MACHINERY

MAY, 1914

MODERN EQUIPMENT FOR INDUSTRIAL PLANTS

A COLLECTION OF METAL EQUIPMENTS THAT ARE DURABLE AND FIREPROOF

BY HARRY C. SPILLMAN*

THE design and selection of factory equipment, such as partitions, bins, racks, etc., seldom receive the proper attention. Often a wood partition is installed which has to be removed in a few months; likewise, a bin or rack becomes obsolete in a short time, and whenever a condition like this occurs the material is broken up and usually ends in a bon-fire. Few manufacturing plants realize the vast loss which occurs in this way, and, in reality, it is one of the serious wastes in a plant. Going concerns are compelled to make changes almost continuously, and as a large amount of this equipment is built in their own shops by millwrights and carpenters, they do not appreciate the enormous cost involved. Often the foremen of a plant are allowed to order the necessary equipment for their departments, and they do not appreciate its cost. One large manufacturing concern discovered the folly of this plan and appointed a committee which had to pass and sanction the building and purchasing of all new equipment. Modern factories are usually housed in fireproof buildings but the value of fireproof equipment is often overlooked. Most industrial plants have very few firewalls, and in case a fire starts in a large room containing a quantity of wooden equipment, which, as a rule, is more or less saturated with oil, it is almost certain to spread very rapidly and the fireproof construction of the building will have very little effect in checking it.

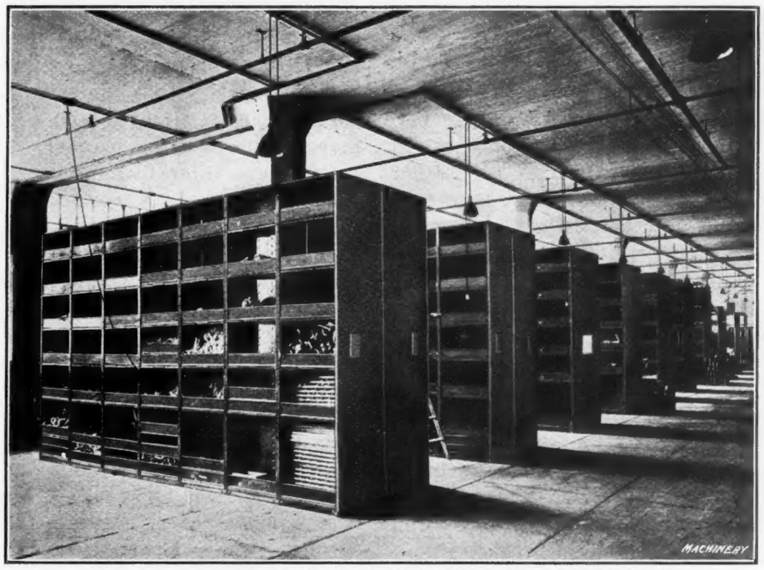

Fig. 1. Arrangement of Metal Stock Bins made up in Sections

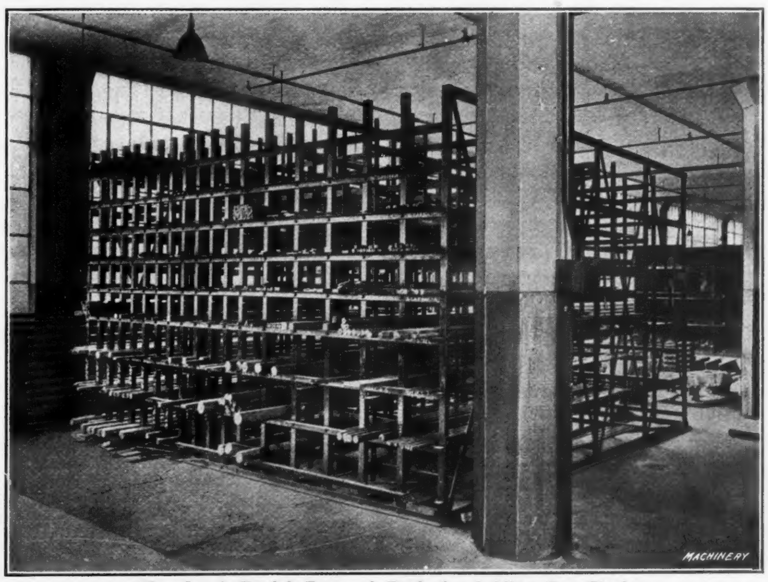

Fig. 2. A Useful Form of Rack for holding Bar Stock

The illustrations in this article show some of the devices which can be made out of metal at a cost that compares favorably with wood. Fig. 1 shows metal bins made up in sections which allows any size or combination of shelves. It is a unit system of construction by which the sections are made to form a concrete whole. These bins are designed to carry a load of 400 pounds per square foot of shelf with a large factor of safety. The sections are bolted together which allows them to be easily altered or taken down and stored away when not required. Considering the slight difference in the first cost of metal and the great advantage of being fireproof, sanitary, adjustable and made up in sections, it is more than good policy to give preference to metal bins. An inexpensive bar rack is shown in Fig. 2. This bar rack is made out of 2 by 2 by 1/4 inch angle irons bolted together. Flat bars 2 by 1/4 inch in size are bolted along the sides and placed diagonally in order to add to its strength and rigidity. A bar rack is subject to a large amount of abuse, and at times it must support an enormous load. This rack will meet these requirements and it is self supporting and can be easily made and erected.

The problem of taking care of workmen's clothes can only be solved by using individual lockers. Nothing is more unsightly in a work-room than the street clothes of the work-men scattered along the walls and work-benches. Fig. 3 shows a locker room containing metal lockers which are well adapted for shop use. These are set up in solid groups and each group contains a number of lockers which costs less than having each compartment built as a separate unit. Each locker is 36 inches high, 12 inches wide and 15 inches in depth, and they are made up in double tiers. They are supported on legs 6 inches high which gives sufficient space to sweep underneath. Each compartment contains a hat shelf and five two-prong steel hooks. The doors are made of 3/4-inch, diamond-mesh, 15-gage expanded metal which gives good ventilation and shows at a glance the contents. Each locker is numbered and has a master keyed flat key lock fitted with a three-way locking device. The compact and sanitary features, protection against fire and security against petty theft make these lockers particularly suitable for industrial plants. The use of pipe for railings, belt guards and skeleton racks is another valuable feature to adopt for industrial plants. Fig. 4 shows an excellent method for supporting time clocks on a skeleton rack. They are rigidly supported on 1 1/4-inch steel pipe securely anchored to the floor and ceiling. A pipe railing is installed beside each clock in order that the workmen will form in line and only one man at a time can reach the clock. As a rule time clocks receive

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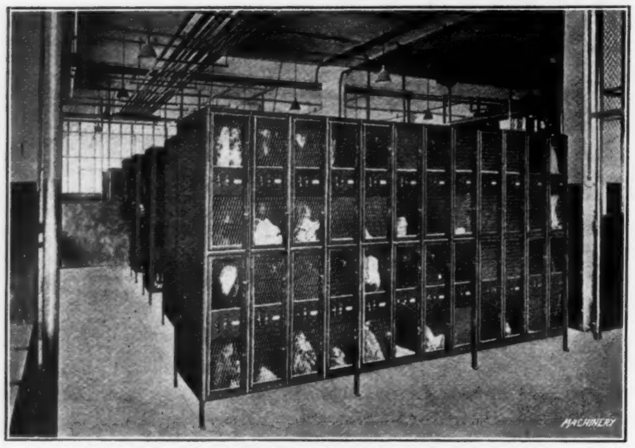

Fig. 3. Sanitary Metal Lockers for holding Workmen's Street Clothes

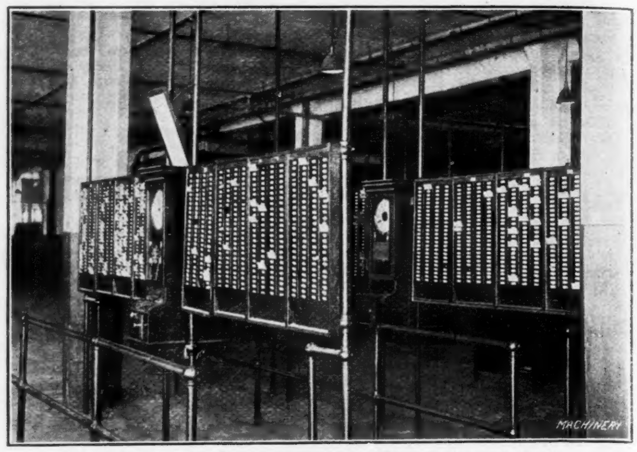

Fig. 4. Time Clocks supported by Pipe Racks and Rails to keep Men in Line

very rough treatment and are easily thrown out of adjustment. A framework of this kind is rigid and also makes a neat and attractive support for the clocks.

Wooden partitions are a fire menace and according to insurance reports they supply excellent fuel to a fire. Metal partitions are far more attractive; they have a larger percentage of glass area, and if made up in standard width sections, it is an easy matter to remove them to some other location. Unfortunately, wooden partitions cannot be moved without practically wrecking the material. A partition which is self supporting and made up in unit sections is shown in Fig. 5. This style of partition has recently been placed upon the market and its many advantages are shown in the illustration. Fig. 6 shows a very inexpensive metal partition which can be built at almost the same cost as a wooden one. This style of partition is made up in sections 4 feet wide, and a 4 by 1/4 inch stiffening bar is placed between each section, which adds to its stiffness. The framework of the panel is made up of 1-inch angle irons having a metal panel 4 feet high for the lower portion. This panel is made out of No. 10 gage steel and riveted to the angle iron frame. The upper space of the panels is divided into sections for supporting the glass. Either 1/8 inch ribbed or double strength American glass is used. The glass is bedded in metal putty and wooden pegs are used instead of glazing points; the glass is also back puttied which holds it rigidly in place. The doors are made of the same material, using 1 by 1/8-inch angle iron for the framework and 1-inch channels for the door stops. The glass in the doors is held in place with metal strips instead of putty. This illustration also shows a watchman's and fire alarm box located on the column. Near the ceiling is an autocall bell and on the floor is shown an inexpensive shop cuspidor made out of pressed steel. The wiring is encased in steel conduit, and although the building is fireproof a sprinkler system is installed. Equipment of this kind is an excellent means for keeping the insurance rate down to a minimum, and it shows the results which can be accomplished by giving the subject the proper study.

Fig. 7 gives an excellent example of wire partitions worked out on the unit basis. These partitions are made up in sections 4 feet wide and have a metal panel below. The framework is 1-inch channel iron and the woven wire is No. 10 gage, having a 1-inch mesh. The corners of these partitions and all door openings are reinforced with a 2-inch steel pipe securely anchored to the floor and ceiling. This gives the partition more strength and protects the corners and openings in an effective manner. The design of work-benches should have careful attention, as most plants have considerable bench work. A work-bench poorly installed continually demands repairing. Fig. 8 shows a work-bench with a 3- by 12-inch maple plank along the front and the remainder of the top covered with maple flooring having a 2-inch face. A 1- by 6-inch timber along the back supports the maple flooring and also allows the legs to be placed from 8 to 10 feet apart, instead of the usual 6-foot spacing. The metal legs are provided with two cross braces for supporting shelves underneath the bench. A strip of wood is placed along the back and ends to keep small parts from rolling off. The woodwork is given a coat of shellac which adds to its appearance and preserves the wood. The bench drawer shown in this illustration is made out of heavy metal and is equipped with trays divided into compartments. The drawers have separate change keys which are master keyed with the lockers. The price of these bench drawers ran slightly lower than the same size made out of wood, which shows that metal equipment compares favorably with wood. The design will be fully understood by referring to Fig. 9.

Fig. 10 shows a Dormant scale which is built into the floor. The scale has an indicating dial and tare beam which makes a quick and effective method for weighing material in a receiving room. The scale is made entirely out of metal except the central portion of the platform; this is made flush with the floor, which is convenient for weighing material carried on trucks. Metal channel irons and I-beams bolted to the ceiling and trusses for supporting hangers and shafting is a far better method than using wood stringers. The power transmission equipment does not get out of alignment from the shrinkage of the stringers and there is less danger of the bolts and nuts becoming loose and doing considerable damage.

The introduction of a factory fence made of metal is fast

Fig. 5. Metal and Glass Partitions made up in Unit Sections

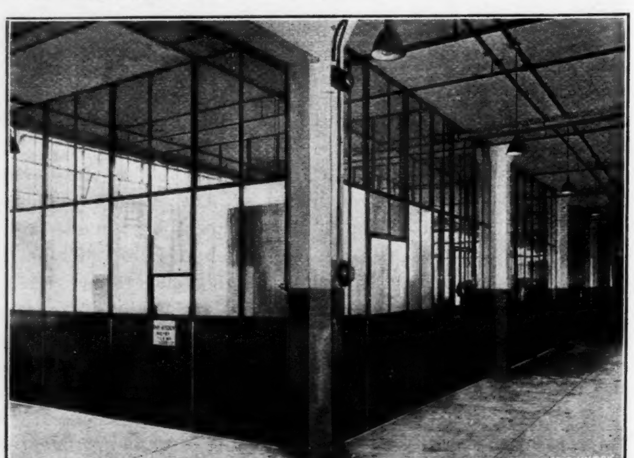

Fig. 6. An Inexpensive Form of Metal and Glass Partition

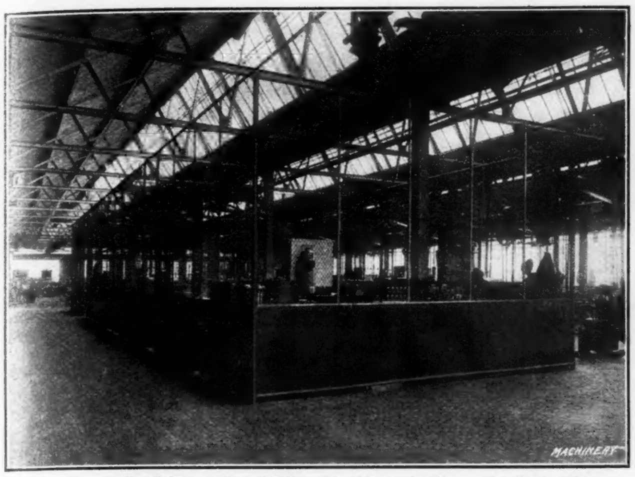

Fig. 7. A Good Example of Wire Partitions built on the Unit Plan

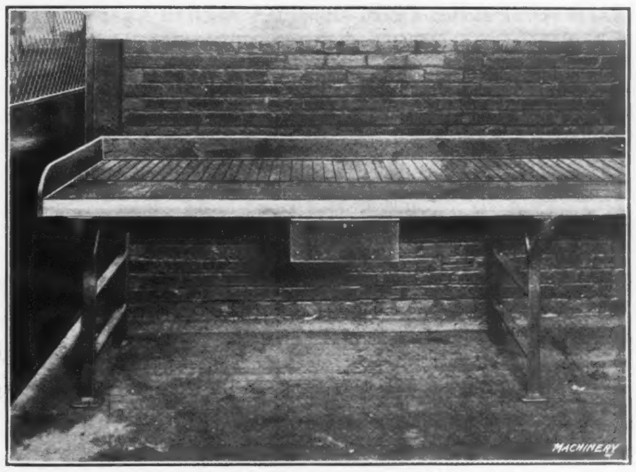

Fig. 8. A Substantial Form of Work-bench

causing the disappearance of the wooden fence which continually demands repairs. Fig. 11 shows a non-climbable fence which will stand up under rough abuse. The posts are spaced eight feet apart and imbedded in concrete. They are made out of 2-inch galvanized pipe and a 3/4-inch pipe ties the top of the posts together. A close woven wire mesh made out of No. 9 gage galvanized wire is stretched between the posts and the fence is made unclimbable by means of five strings of heavy barbed wire along the top. An industrial plant enclosed with a fence of this type is made far more attractive than one enclosed with tight boards. By careful planning and giving metal the preference, the equipment of a plant can be made completely fireproof. It will possess the greatest possible strength and stability and have the combined qualities of adjustability and adaptation for the many uses and changes necessary for the equipment of a going concern.

* * *

ALUMINUM CHEAPENING

The housewife who steps into the hardware store to price an aluminum kettle or saucepan and pays handsomely for it without complaining because the kettle is worth it in convenience and durability, perhaps does not always realize that aluminum is no longer the rare, expensive metal it was portrayed to be not many years ago. She does not know that aluminum is now quoted on the open market at 19 cents a pound, with copper at 14½ cents and tin at 38½ cents. Furthermore, the price figures of 19 and 14½ cents for aluminum and copper are misleading, since, because aluminum is only three-tenths as heavy as copper, for most purposes only three-tenths as much by weight of the metal is needed. The metal for a vat weighing ten pounds made of copper ought to cost $1.45; the aluminum for a vat of the same size would weigh three pounds and ought to cost 57 cents. The use of aluminum in the industries is still in its early stages, and the manufacturing cost is still excessive, but we may shortly expect lower prices.

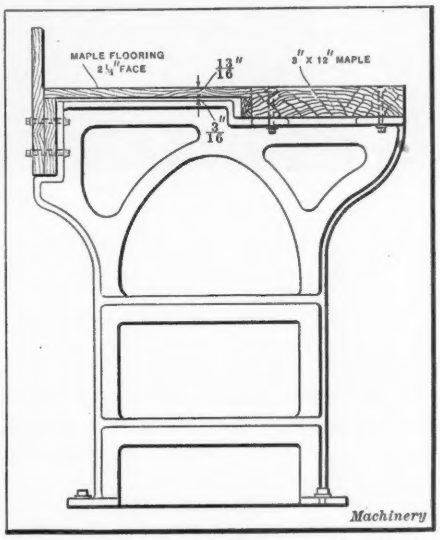

Fig. 9. End View of Bench shown in Fig. 8

It is no doubt the prevailing opinion that iron is the most abundant of all metals. As a matter of fact, of all the seventy odd elements which make up the earth, only two are more abundant than aluminum—namely, oxygen and silicon—and these are not metals. Besides, it is of common occurrence, being a principal ingredient of the ordinary clay that the farmer turns up every time he lets the points of his plow down into the subsoil. This clay contains sometimes as much as 25 per cent of aluminum in chemical combination with silicon. However, as yet no process has been devised by which it can be recovered cheaply from common clay. The metal now on the market is reduced from the mineral bauxite, which is found in Georgia, Alabama and Arkansas in this country, in County Antrim in Ireland, and in the north of France. The process for its reduction was developed in the years from 1886 to 1889 by C. M. Hall in this country and P. T. L. Heroult in France. The pure oxide of aluminum is heated to melting by an electric current and separated electrolytically while in this condition from the oxygen.

Weight for weight, aluminum is stronger than any other metal except the best cast steel and some of its own alloys. Therefore it is coming into considerable use in boat building and other kinds of construction where lightness is an object. As a conductor of electricity, an aluminum wire 0.126 inch diameter carries the same current as a copper wire 0.100 inch diameter and weighs only 69 pounds per mile, while the copper weighs 162 pounds per mile—*Michigan College of Mines Bulletin.*

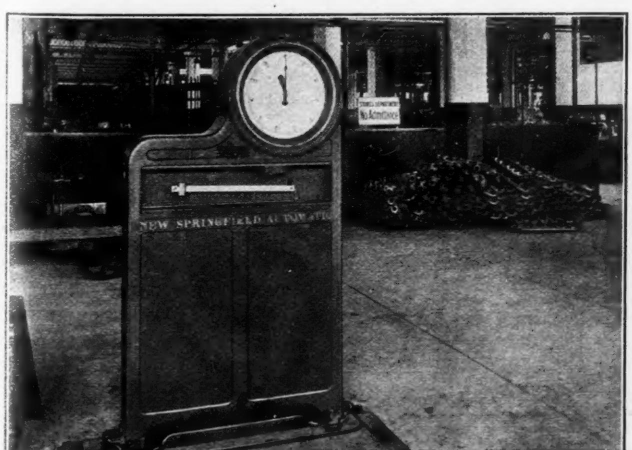

Fig. 10. Dormant Scale built Flush with the Floor to facilitate weighing

Fig. 11. "Non-climbable" Factory Fence made entirely of Metal

OIL SEPARATOR EQUIPMENT OF THE NEW PROCESS GEAR CORPORATION

The New Process Gear Corporation, Syracuse, N. Y., manufactures gears, automobile differentials, transmission gears, etc., and in the various machining operations performed produces about two tons of oil-soaked chips daily. The oil is removed from the chips in the separator room shown in Figs. 1 and 2. The apparatus used includes a steam turbine driven separator made by the Oil & Waste Saving Co. of Philadelphia, Pa., a machine simple in construction, consisting of a vertical shaft carrying a bucket wheel and a basket in which the chips are deposited. Steam for driving the wheel is admitted through a nozzle from which it impinges on the bucket wheel and drives it and the separator basket at high speed. The use of steam for driving a centrifugal separator directly eliminates the belt troubles incident to belt-driven separators and it also provides heat for warming the chips, thus facilitating the separation of the oil.

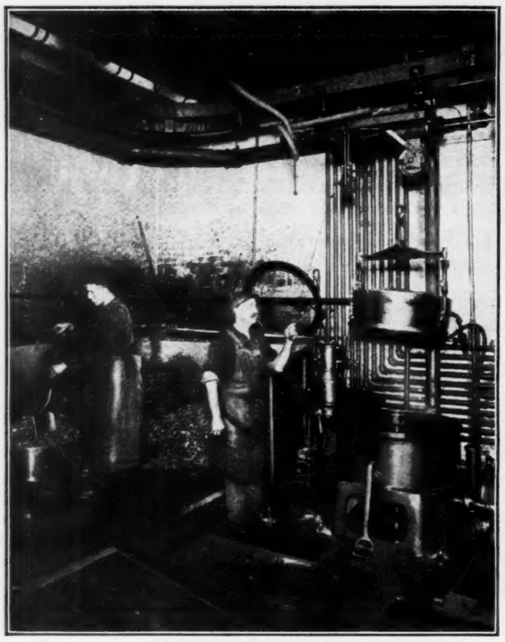

Fig. 1. Steam Turbine Oil Separator used in New Process Gear Corporation Plant

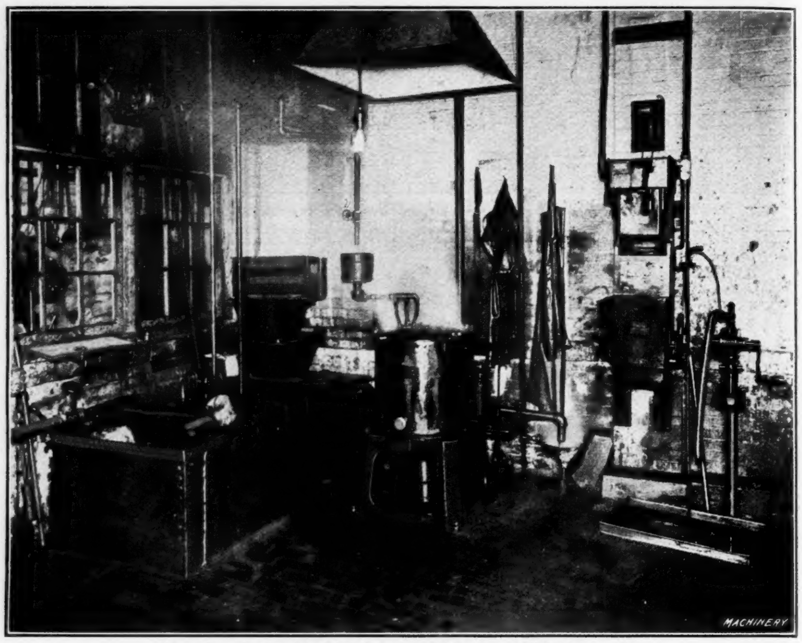

Fig. 2. Steam Turbine-driven Oil-drying, Filtering and Sterilizing Machine

The separator baskets are filled with chips shoveled from the chip bin in the corner and are then transported to the separator by the overhead trolley and pneumatic hoist. They are lowered into the separator and a heavy cast-iron cover mounted on a vertical spindle is swung into place when the basket is in position. Thus, all heavy lifting by the attendants is avoided.

The operation of starting the machine and separating the oil from a basket of chips requires but a few minutes. The separated oil runs through a pipe into a sump and from the sump it is lifted to a tank shown in Fig. 2 with a geared pump driven by a small electric motor. This tank acts as a settling place where the fine chips and dirt are partially removed. From the tank the oil is directed into a centrifugal oil drying and sterilizing machine made by the same concern that manufactures the steam turbine separator. The function of this machine is to evaporate the water contained in the oil and to subject the oil to a temperature that will sterilize it and thus reduce the danger of blood poisoning of screw machine operators to a minimum. It also filters the oil.

A cross-section of the machine is shown in Fig. 3. It consists of a cast-iron case in which is mounted a vertical spindle carrying the steam turbine bucket wheel and the separator basket. The oil flows into this separator and is hurled by centrifugal force through the filtering medium lining it. The oil flies from the outside of the basket against the steam coils which are filled with high temperature steam. Then being in a finely divided condition, it is instantly raised to a high temperature and the water is evaporated, escaping as steam through the holes in the top. The dry and sterilized oil flows from the machine into another sump, from which it is raised by a hand pump shown at the right in Fig. 2, and drawn into cans for distribution throughout the plant. Two men are employed in the separator room. They handle about three tons of oil-soaked chips daily, from which about 200 gallons of oil is extracted. The oil, being free from water and in a practically sterile condition, is an efficient and safe lubricant.

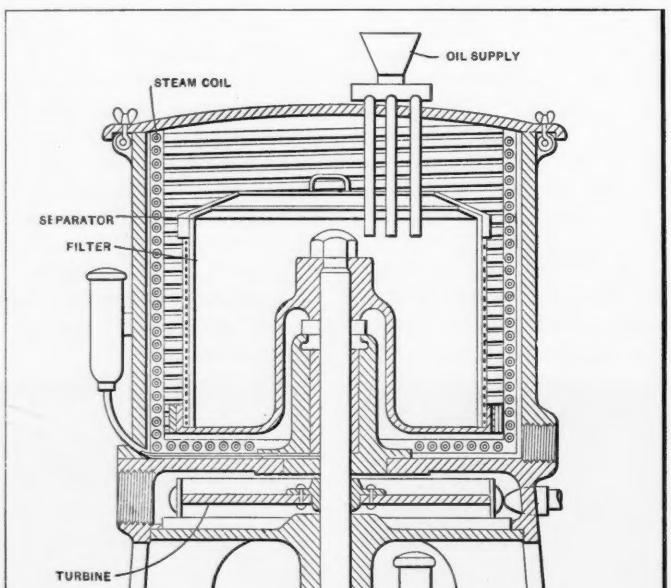

Fig. 3. Vertical Section through Oil-drying, Filtering and Sterilizing Machine

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An invention has been made by a citizen of Reichenberg, Bohemia, for producing a substitute for all classes of marble, including the most highly priced Italian marble. It is claimed that the artificial product is fully as strong or stronger than the genuine article, that it is less liable to cracks or surface damage, and that especially in working, drilling, or mounting work upon it, the danger of injury to it is less than with the real marble, although it is only one-third the price. Factories for producing this product are already in operation in Vienna, Berlin, Mannheim and Hamburg, and arrangements have been made for selling the British patent rights to a London company.

THE CLEVELAND AUTOMATIC SCREW MACHINE—2

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON*

THE turret end of the Cleveland automatic screw machine incorporates a number of interesting mechanical movements and features of design that are well worth attention. Among these are the details used for indexing and locking the turret, the methods of rotating, and the means employed for regulating the feed of the tools. These various details will be taken up in the order of their relation, as regards position, to the turret drum.

Turret and Turret Slide

The turret J, as shown in Figs. 11, 13 and 14, is of the drum type and is carried on a shaft A_2, parallel with the axis of the work-spindle. The turret on the 3¼-inch machine accommodates six tools, which are held by two clamping bolts each, in the holes in the front end of the turret, and are located concentrically with the axis of the work-spindle. The turret J is driven forward and backward by a cam drum K which is free to rotate on shaft A_2 and carries segment cams B_2 fastened to its periphery. These cams work against the roll C_2 which is held on a stud driven into a hole in the base of the machine, and owing to its positive relation to the axis of the tools in the turret gives a very rigid drive; that is, the angle made by the position of the roll in relation to the axis of the tools is very slight, obviating any cramping of the turret and giving almost a straight-line drive to the turret tools. Cast integral with a drum K is a spur gear D_2 which rotates it. Gear D_2 receives power from the pinion E_2 beneath it that acts as a "continuous" key. Pinion E_2, in turn, is rotated by gear F_2 keyed to the same sleeve as that on which the worm-wheel G_2 is held. The method of driving the worm-wheel at different speeds—for the cutting and idle movements of the machine—will be described later.

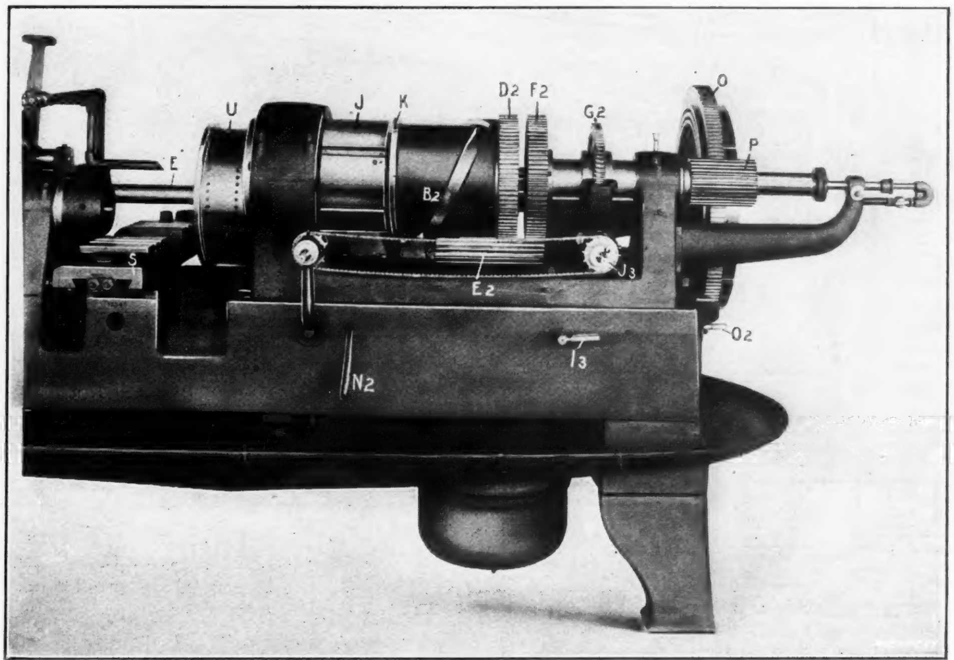

Fig. 11. Turret End of 3¼-inch Cleveland Automatic Screw Machine

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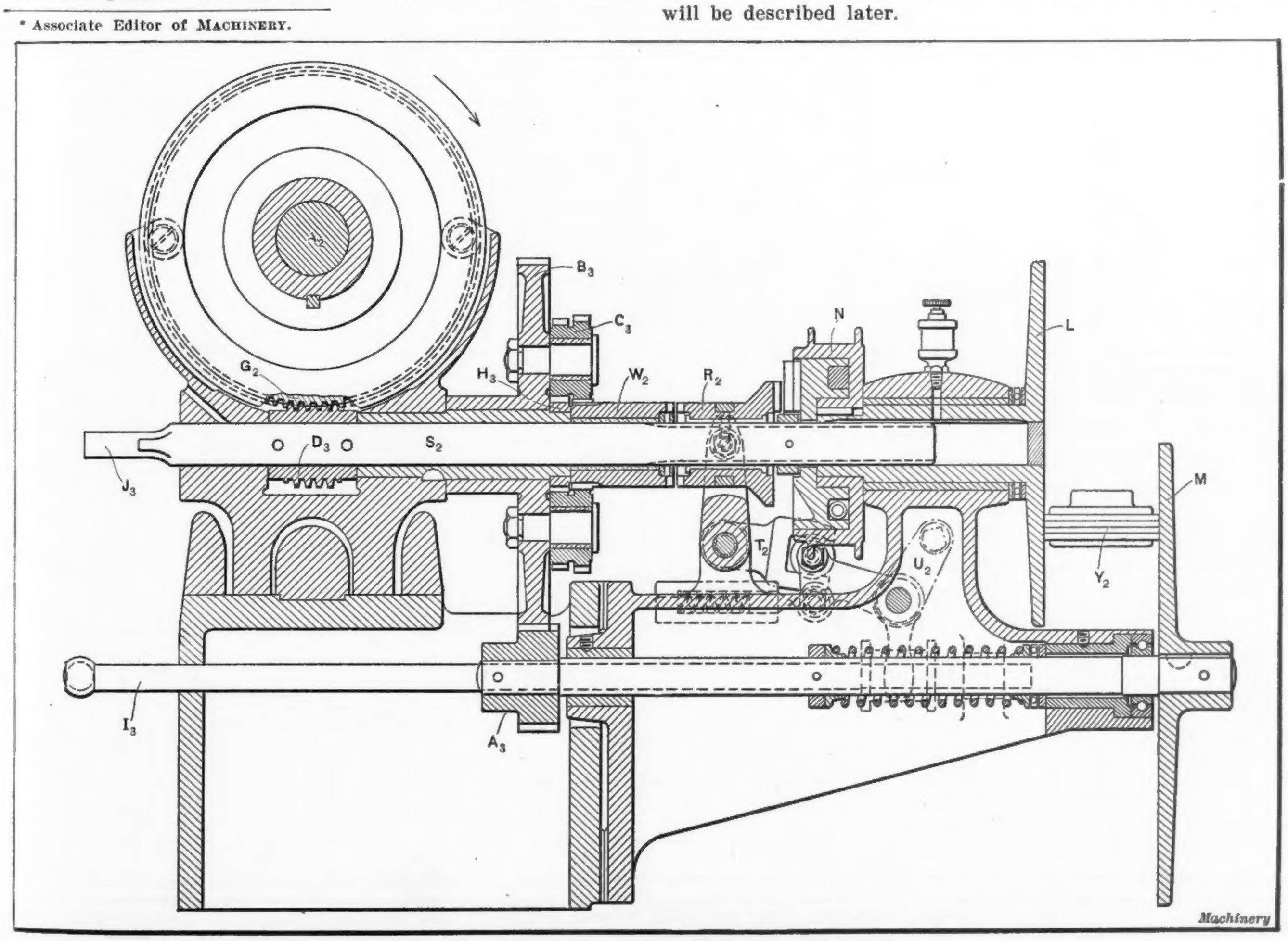
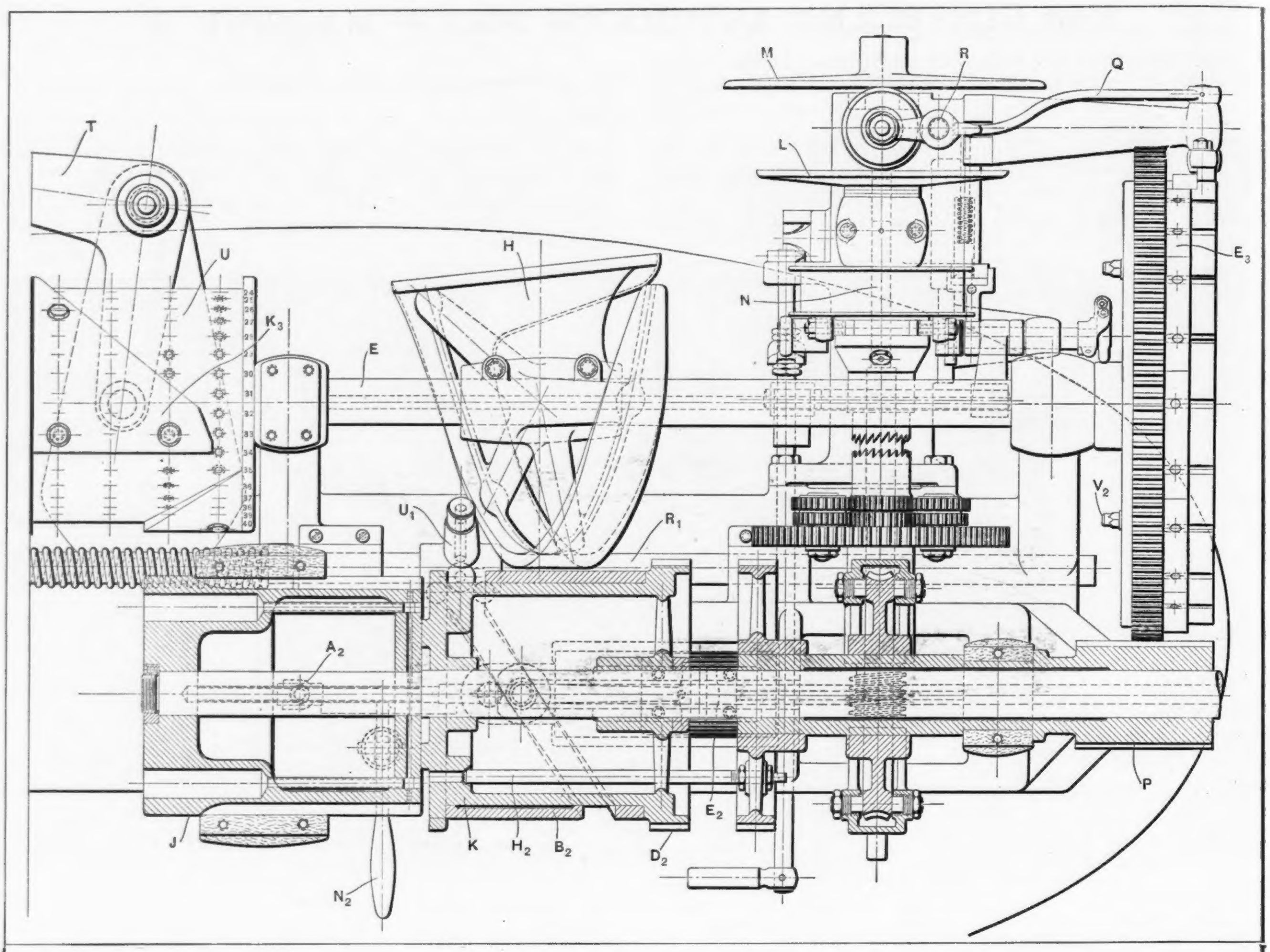


Fig. 12. Sectional View showing Feed driving Mechanism



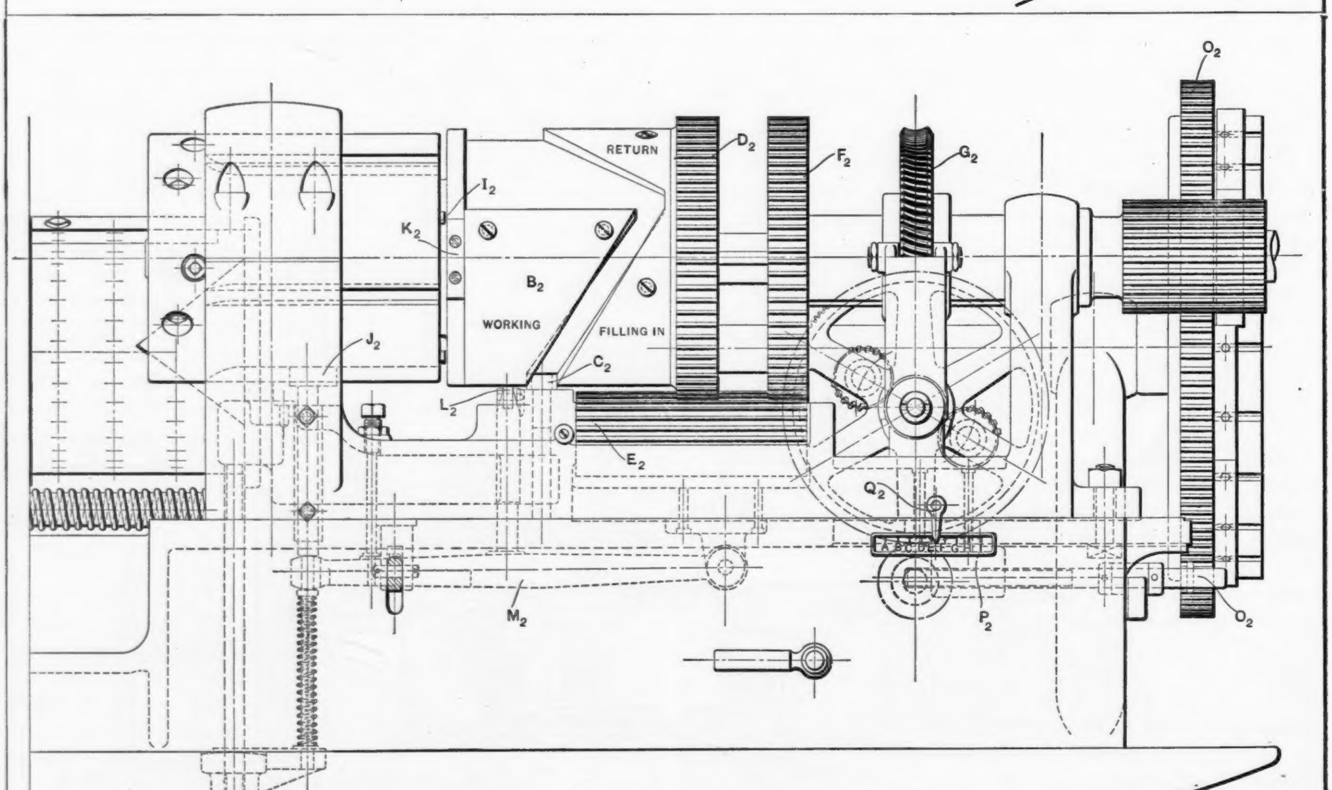


Fig. 13. Sectional Plan View of Turret End of Cleveland Automatic, showing Construction of Turret, Regulating Drum and Auxiliary Mechanism. Fig. 14. Front Elevation of Turret End of Cleveland Automatic

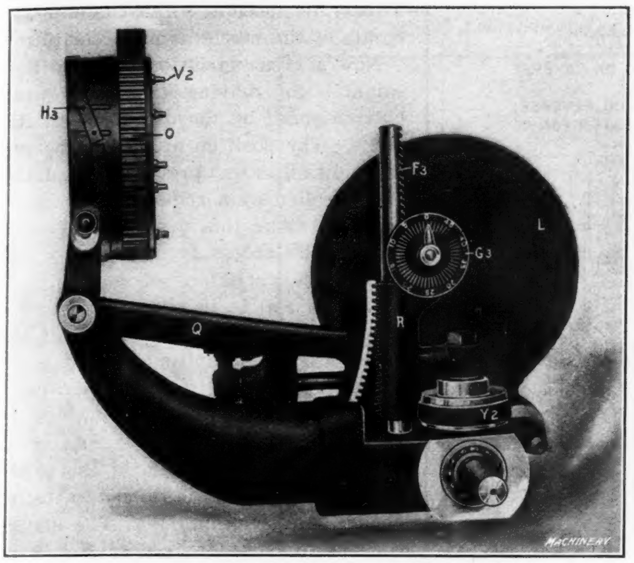


Fig. 15. Detailed View showing Feed Roll

The turret is indexed upon its back stroke by means of a rod H_2 held adjustably by locking nuts in the gear F_2, which comes in contact with hardened pins I_2 held in the rear face of the turret. Before the turret can be turned around, however, it is necessary to disengage the locking wedge J_2 from the slot in the circumference of the turret. This is accomplished by means of a cam block K_2 held on the flange of drum K which contacts with the pin L_2. This pin, in turn, is fastened to a lever M_2 located in the bed of the machine, which is spring-controlled and holds up the locking wedge J_2 in the manner illustrated in Fig. 14. As the turret retreats, cam K_2 comes into contact with plunger L_2, depressing lever M_2 and pulling down the locking wedge J_2, thus disengaging it from the slot in the turret circumference. Then the turret is indexed by the rod H_2 as previously described. The indexing can be also effected by hand by simply depressing the handle N_2 which has the same action on the locking wedge as the cam block held upon the drum K. The turret can be

TABLE I. SPINDLE CAPACITIES OF CLEVELAND AUTOMATIC SCREW MACHINES

Size of Machine in Inches	Spindle Capacities in Inches for Round, Hexagon and Square Stock								
	Solid Shell Chuck			Pads in Chuck			Pads in Feed Tube		
	Round	Hexagon*	Square*	Round	Hexagon*	Square*	Round	Hexagon*	Square*
3/8	3/8	5/16	1/4	.....	.....	.....	.....	.....	.....
3/8–1/2	9/16	15/32	3/8	.....	.....	.....	.....	.....	.....
3/8–5/8	5/8	17/32	7/16	.....	.....	.....	.....	.....	.....
5/8	5/8	17/32	7/16	.....	.....	.....	.....	.....	.....
5/8–3/4	3/4	5/8	1/2	.....	.....	.....	.....	.....	.....
5/8–7/8	7/8	3/4	19/32	.....	.....	.....	.....	.....	.....
5/8–1 1/16	1 1/16	29/32	3/4	.....	.....	.....	.....	.....	.....
7/8	7/8	3/4	19/32	.....	.....	.....	.....	.....	.....
7/8–1 1/16	1 1/16	29/32	3/4	.....	.....	.....	.....	.....	.....
7/8–1 1/4	1 5/16	1 1/8	29/32	.....	.....	.....	.....	.....	.....
7/8–1 3/8	1 3/8	1 3/16	31/32	.....	.....	.....	.....	.....	.....
1 1/4	1 5/16	1 1/8	29/32	.....	.....	.....	.....	.....	.....
1 1/4–1 3/8	1 3/8	1 3/16	31/32	.....	.....	.....	.....	.....	.....
1 1/4–1 1/2	1 1/2	1 9/32	1 1/16	.....	.....	.....	.....	.....	.....
2	2 3/16	1 7/8	1 1/2	1 15/16	1 11/16	1 3/8	1 15/16	1 11/16	1 3/8
2 –2 1/2	2 1/2	2 5/32	1 3/4	2 1/4	1 15/16	1 19/32	2 1/4	1 15/16	1 19/32
2 –2 3/4	2 13/16	2 7/16	1 31/32	2 5/8	2 1/32	1 21/32	2 5/8	2 1/32	1 21/32
2 1/4	2 1/2	2 5/32	1 3/4	2 1/4	1 15/16	1 19/32	2 1/4	1 15/16	1 19/32
2 1/4–2 3/4	2 13/16	2 7/16	1 31/32	2 5/8	2 1/32	1 21/32	2 5/8	2 1/32	1 21/32
2 1/4–3 1/4	3 1/4	2 13/16	2 9/32	3	2 19/32	2 1/8	2 7/8	2 1/2	2 1/32
2 3/4	2 13/16	2 7/16	1 31/32	2 5/8	2 1/32	1 21/32	2 5/8	2 1/32	1 21/32
2 3/4–3 1/4	3 1/4	2 13/16	2 9/32	3	2 19/32	2 1/8	2 7/8	2 1/2	2 1/32
2 3/4–3 3/4	3 7/8	3 11/32	2 3/4	3 3/4	3 1/4	2 21/32	3 3/4	3 1/4	2 21/32
4 1/4	4 9/16	3 15/16	3 7/32	4 3/8	3 25/32	3 3/32	4 3/8	3 25/32	3 3/32
6 1/4	6 1/4	5 13/32	4 13/32	6 1/4	5 13/32	4 13/32	6 1/4	5 13/32	4 13/32
6 1/4–6 3/4	6 3/4	5 27/32	4 25/32	6 3/8	5 1/2	4 1/2	6 3/8	5 1/2	4 1/2
7 1/4	7 1/4	6 9/32	5 1/8	7 1/4	6 9/32	5 1/8	7 1/4	6 9/32	5 1/8
7 1/4–7 3/4	7 3/4	6 23/32	5 15/32	7 3/8	6 3/8	5 7/32	7 3/8	6 3/8	5 7/32

Machinery

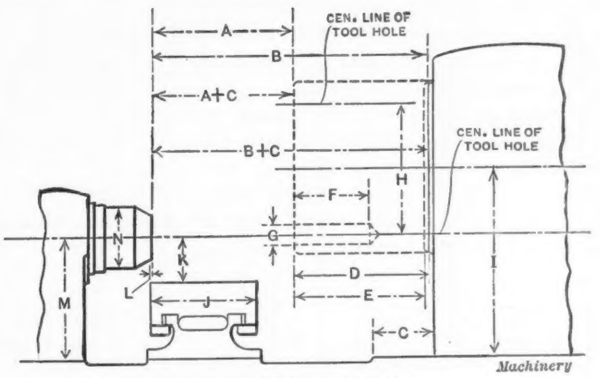
* The sizes for hexagon and square stock are given to the nearest 1/32 inch to the corresponding diameters of round stock.

rotated by hand by means of a handle which fits on shaft J_3.

The turret head, which has two bearings as illustrated, one of which supports the central shaft A_2 and the other the turret J, is mounted on the bed of the machine and can be adjusted to suit various lengths of work and tools held in the turret. This adjustment is effected by means of the screw O_2 which works in a threaded projecting lug cast integral with the base of the turret head casting. The turret is held to the base of the machine by means of bolts as illustrated. A scale P_2, fastened to the base of the machine, and a pointer Q_2, held on the turret-slide, enable the operator to obtain the same setting of the turret head when setting up a job for the second time.

The method of driving and rotating the turret is clearly illustrated in Fig. 12 which shows a section of the driving

TABLE II. PRINCIPAL DIMENSIONS OF TURRET, CROSS-SLIDES AND MISCELLANEOUS DATA



A=TURRET HEAD IN FRONT POSITION.
B=TURRET HEAD IN REAR POSITION.
C=ADJUSTMENT OF TURRET SLIDE ON BASE.
D=GREATEST MILLING STROKE.
E=TOTAL ADVANCE OF TURRET HEAD.
O=APPROXIMATE LENGTH THAT CAN BE FORMED.
P=MAXIMUM LENGTH OF STOCK FEED.

Principal Dimensions in Inches	Sizes of Machines. Rated Chuck Capacities in Inches*									
	3/8	5/8	7/8	1 1/4	2	2 1/4	2 3/4	4 1/4	6 1/4	7 1/4
A	2 7/32	3 3/16	4 1/16	5 3/16	4 5/8	6 1/4	6 13/16	8 1/4	10	10
B	4 23/32	7 3/16	9 1/16	11 7/16	10 7/8	13 5/8	14 13/16	17 5/8	19 3/8	19 3/8
C	1 3/4	2 1/2	3 1/2	4	4	5 1/4	5 1/2	7	7 1/4	7 1/4
A+C	3 31/32	5 11/16	7 9/16	9 3/16	8 5/8	11 1/2	12 5/16	15 1/4	17 1/4	17 1/4
B+C	6 15/32	9 11/16	12 9/16	15 7/16	14 7/8	18 7/8	20 5/16	24 5/8	26 5/8	26 5/8
D	2 1/2	4	5	6 1/4	6 1/4	7 3/8	8	9 3/8	9 3/8	9 3/8
E	2 1/4	3 3/4	4 3/4	6	6	7	7 5/8	9	9	9
F	3 3/8	4 1/2	5	5	5	6 1/4	7	8	8	8
G	7/8	1 1/16	1 1/4	1 1/2	1 1/2	1 3/4	2	2 1/4	2 1/4	2 1/4
H	3 1/2	4 1/2	5 1/2	7 1/2	7 1/2	8	8 3/4	10	10	10
I	6	7 1/4	8 1/4	10 3/4	10 3/4	12	13 3/8	15	15	15
J	3 3/4	5 1/2	6 5/8	6 3/4	6 3/4	8	7 11/16	8 1/8	10 1/8	10 1/8
K	1 5/16	2 1/4	2 3/8	2 5/8	2 5/8	2 3/4	2 3/4	4	4 1/4	4 1/4
L	23/32	1 21/32	1 11/16	11/16	1 1/4	1 1/8	3/16	.....	.....	.....
M	4 1/4	5	5 1/2	7	7	8	9	10	11 1/2	11 1/2
N	1 5/8	2 1/4	2 5/8	3 5/8	5 3/16	5 3/4	6 1/2	10 5/8	15 19/32	15 19/32
O	3/4	1 3/4	3	4 1/4	4 1/4	5 1/2	6	6 1/4	6 1/4	6 1/4
P	4 3/4	6 1/2	8 1/2	10 1/2	10 1/2	12 5/8	13 5/8	16 5/8	16 5/8	16 5/8
Approximate Horsepower required to Drive										
H P.	1	1 1/2	2	2 1/2	3	4	5	6	8	10

Machinery

* For work which does not require heavy cuts these sizes of machines can be obtained in the following increased sizes: 3/8—1/2; 3/8—5/8; 5/8—3/4; 5/8—7/8; 5/8—1 1/16; 7/8—1 1/16; 7/8—1 1/4; 7/8—1 3/8; 1 1/4—1 3/8; 1 1/4—1 1/2; 2—2 1/2; 2—2 3/4; 2 1/4—2 3/4; 2 1/4—3 1/4; 2 3/4—3 1/4; 2 3/4—3 3/4; 6 1/4—6 3/4; 7 1/4—7 3/4.

mechanism located at right angles to the axis of the turret shaft. Power is conveyed to this mechanism from the overhead countershaft through the medium of the pulley N, keyed to the shank of the friction disk L. The method of driving the turret direct or at its fast speed for accomplishing the idle movements of the machine is as follows: The sliding clutch R_2, shown in its neutral position in the illustration, is thrown to the right and contacts with the pulley N. The power is then direct through the sliding clutch to the worm-shaft S_2 and then to the worm-wheel G_2, turret, etc. The sliding clutch is keyed to the worm-shaft and is operated

through the bellcrank levers T_2 and U_2, which are actuated by dogs V_2 (see Fig. 15) adjustably mounted on the rear face of the regulating drum.

The method of driving the turret at its slow or cutting speed is as follows: The sliding clutch R_2 is thrown to the left by means of the dogs held on the regulating drum, and contacts with the pinion W_2 which has clutch teeth cut in it similar to those on the sliding clutch. The drive is then through pulley N, friction disk L, roller Y_2, disk M, pinion and gear A_3 and B_3 to the epicyclic train of gears C_3 down to the pinion sleeve W_2 and through the sliding clutch R_2 to the worm D_3. The changing from slow to fast speed can also be effected by pushing in or pulling out handle I_3. This reduction in speed with roll Y_2 in the position shown in Fig. 12 is in a ratio of about 25 to 1.

In order to make clear the manner in which this great reduction in speed is accomplished, it might be well to deal briefly with the train of epicyclic gears, giving especially the data relating to the computations involved. Referring

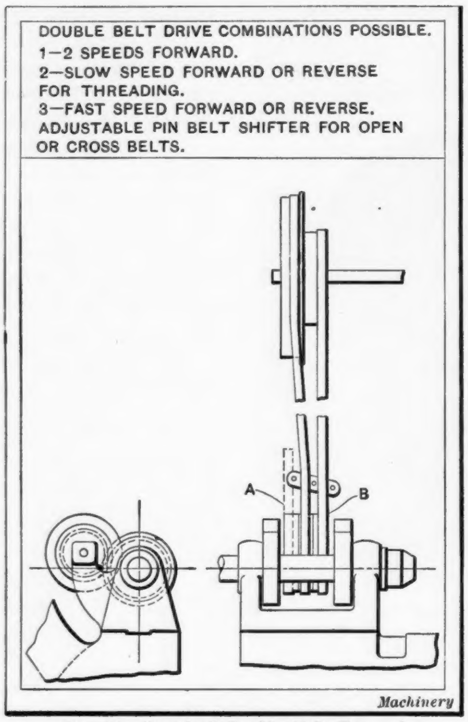


Fig. 16. Standard Double Belt Type of Spindle Drive

This is the speed at which the idle movements of the machine are accomplished.

Now a great variation of speed is obtainable for driving the turret at its cutting speed by the use of the friction disks. The position of the roll between these disks, as was previously explained, is controlled by a regulating drum. In order to make this description clear, it will not be necessary to give any more than three variations of speed, that is when the roll is in the central or neutral position B giving a ratio of 1 to 1, when it is at the extreme outside of the driven disk in position A, and when it is at the outside circumference of the driving disk in position C. As stated, to drive the turret drum at the cutting speed, the clutch R_2 is shifted to the left, engaging with pinion W_2. The drive is then as follows: As pulley N is keyed to the shank of friction disk L, the drive is from pulley N to friction disk L, roller Y_2, disk M, then to pinion A_3, gear B_3, and through the epicyclic gears C_3 and E_3 back to gear W_2 and from there to clutch R_2, shaft S_2 and worm D_3 to worm-wheel G_2.

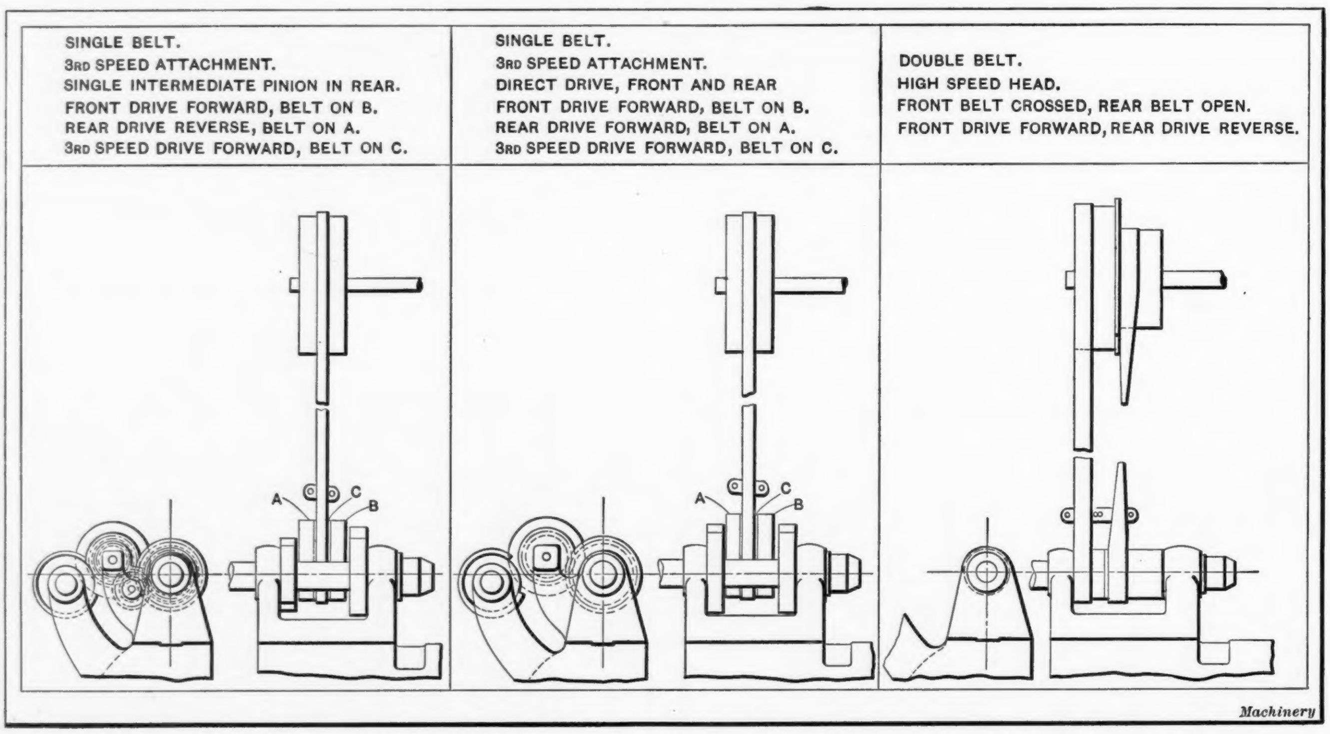


Fig. 17. Third-speed Type of Spindle Drive for Heavy cutting, and High-speed Spindle Drive particularly adapted for Brass Work

to Fig. 18, it will be seen that pulley N, on the 3¼-inch machine, rotates at a constant speed of 630 R. P. M. Then to drive the turret direct, that is at its highest rate of speed, clutch R_2 is thrown to the right and engages with this pulley. The drive is then direct through the clutch to shaft S_2 and from there to the worm D_3 and worm-wheel G_2. Now as pulley N rotates at 630 R. P. M., the shaft S_2 and worm will rotate at the same speed, so that the worm-wheel and the turret drum will be driven at a speed of $630 \div 76$ or about 8.3 R. P. M.

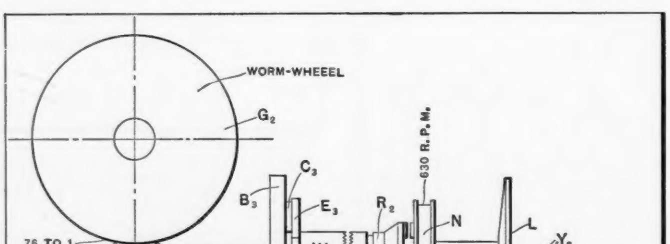


Fig. 18. Diagram showing Ratios of Speeds of Cutting and Idle Movements

Making our calculations with the roll Y_2 in the intermediate position B, giving a speed ratio between the two disks of 1 to 1, we can find the speed of the turret drum in revolutions per minute as follows: With roll Y_2 in the intermediate position, the pinion A_3 will rotate at 630 R. P. M., and the large gear B_3 will rotate at $\frac{630}{5.52}$ or 114 R. P. M., approximately. The next calculation is for the epicyclic train. This can be obtained by using the formula on page 702 of MACHINERY'S

Handbook. Worked out to suit this case it is as follows:

Let S = speed of worm-shaft S_2; then:

$$S = \frac{C_3 \times W_2 - E_3 \times H_3}{C_3 \times W_2}.$$

Assuming the following numbers of teeth in the gears in the epicyclic train to be C_3, 14; E_3, 15; H_3, 16; W_2, 15; we find that the ratio between the speed of gear B_3 and shaft S_2 is

$$\frac{14 \times 15 - 15 \times 16}{14 \times 15} = \frac{30}{210} = \frac{1}{7}.$$

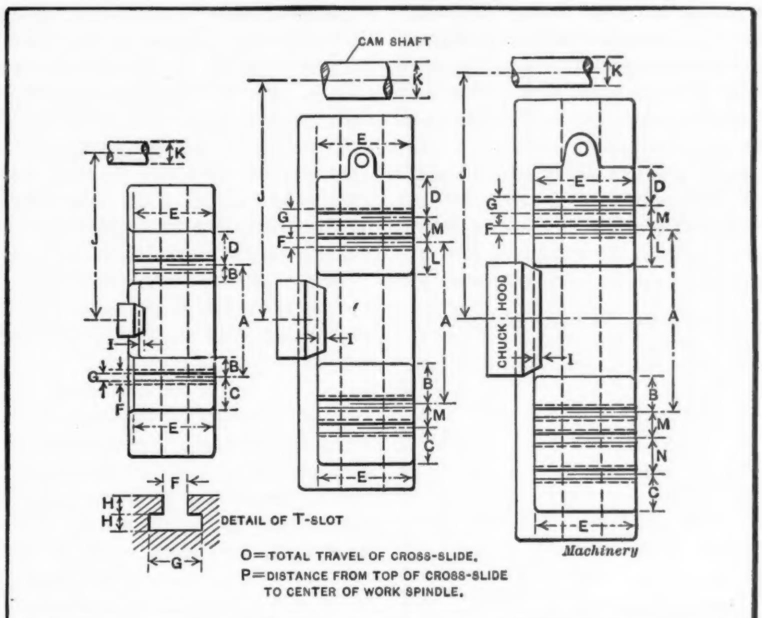
Then as gear B_3 rotates at 114 R. P. M., shaft S_2 will rotate at $\frac{114}{7} = 16.3$ R. P. M., approximately. Then the revolutions of the turret drum with roll Y_2 in position $B = \frac{16.3}{76} = 0.2$ R. P. M., approximately.

With roll Y_2 in position C, the speed of rotation of the turret drum will be $0.2 \times 1.5 = 0.3$ R. P. M., approximately. This is the fastest speed of rotation of the turret drum when driving at the cutting speed. The slowest speed of the turret drum when driving at the cutting speed is when the roll is in position A. Here the speed of the turret will be $\frac{0.2}{6.5} = 0.0308$ R. P. M., approximately.

As previously described, the variation in feed given to the turret and cross-slide tools is accomplished by means of a regulating drum O on which strip cams are held. Fig. 15 shows the action that takes place by shifting one of these cam strips H_3 on the regulating drum. As the cam is shifted, a movement is transmitted to the bellcrank lever Q which has rack teeth cut in its outer end, meshing with teeth in the sliding sleeve R on the rod F_3. This rod is held in a bracket attached to the machine.

Now as a movement is transmitted to the bellcrank lever Q, the sleeve R is moved up and down on the rod, and consequently the position of the roll Y_2 is changed between the two friction disks, thus varying the speed at which the disk M, Fig. 12, is rotated. In order to facilitate set-

TABLE III. PRINCIPAL DIMENSIONS OF CROSS-SLIDES ON MODEL A, CLEVELAND AUTOMATICS



Principal Dimensions in Inches	Sizes of Machines. Rated Chuck Capacities in Inches*									
	3/8	5/8	7/8	1 1/4	2	2 1/4	2 3/4	4 1/4	6 1/4	7 1/4
A	6 1/4	8 1/8	9 3/8	10 1/4	10 1/4	11 3/4	13 1/4	15 1/4	15 1/2	15 1/2
B	1 1/8	1 7/16	1 5/8	2 1/4	2 1/4	2	3 1/4	3 1/8	2 7/8	2 7/8
C	2 3/8	2 3/4	2 11/16	2 3/4	2 3/4	3	3	3 1/8	3	3
D	2 3/8	2 3/4	2 11/16	2 7/16	2 7/16	2 1/4	3 1/4	3 1/8	3 1/2	3 1/2
E	3 3/4	5 1/2	6 5/8	6 3/4	6 3/4	8	7 11/16	8 1/8	10 1/8	10 1/8
F	1/2	9/16	5/8	5/8	5/8	5/8	3/4	3/4	1	1
G	7/8	1 1/16	1 1/8	1 1/8	1 1/8	1 1/8	1 1/4	1 1/4	1 5/8	1 5/8
H	1/4	5/16	3/8	3/8	3/8	3/8	1/2	1/2	5/8	5/8
I	23/32	1 21/32	1 11/16	11/16	1 1/4	1 1/8	3/16	......	......	......
J	7.293	10.256	11.337	12.577	12.577	14.457	16.944	20.396	20.396	20.396
K	1 5/16	1 7/16	1 13/16	1 15/16	1 15/16	2 3/16	2 7/16	3 3/16	3 3/16	3 3/16
L	....	......	......	......	......	......	2 3/4	3 1/8	2 7/8	2 7/8
M	.....	......	......	......	......	......	2	2	3 1/2	3 1/2
N	.....	......	......	......	......	......	......	3	3 1/2	3 1/2
O	4 1/8	6 1/8	7	7 3/4	7 3/4	9 1/4	11 1/4	13 1/4	13 1/4	13 1/4
P	1 5/16	2 1/4	2 3/8	2 5/8	2 5/8	2 3/4	2 3/4	4	4 1/4	4 1/4

Machinery

* See Table II.

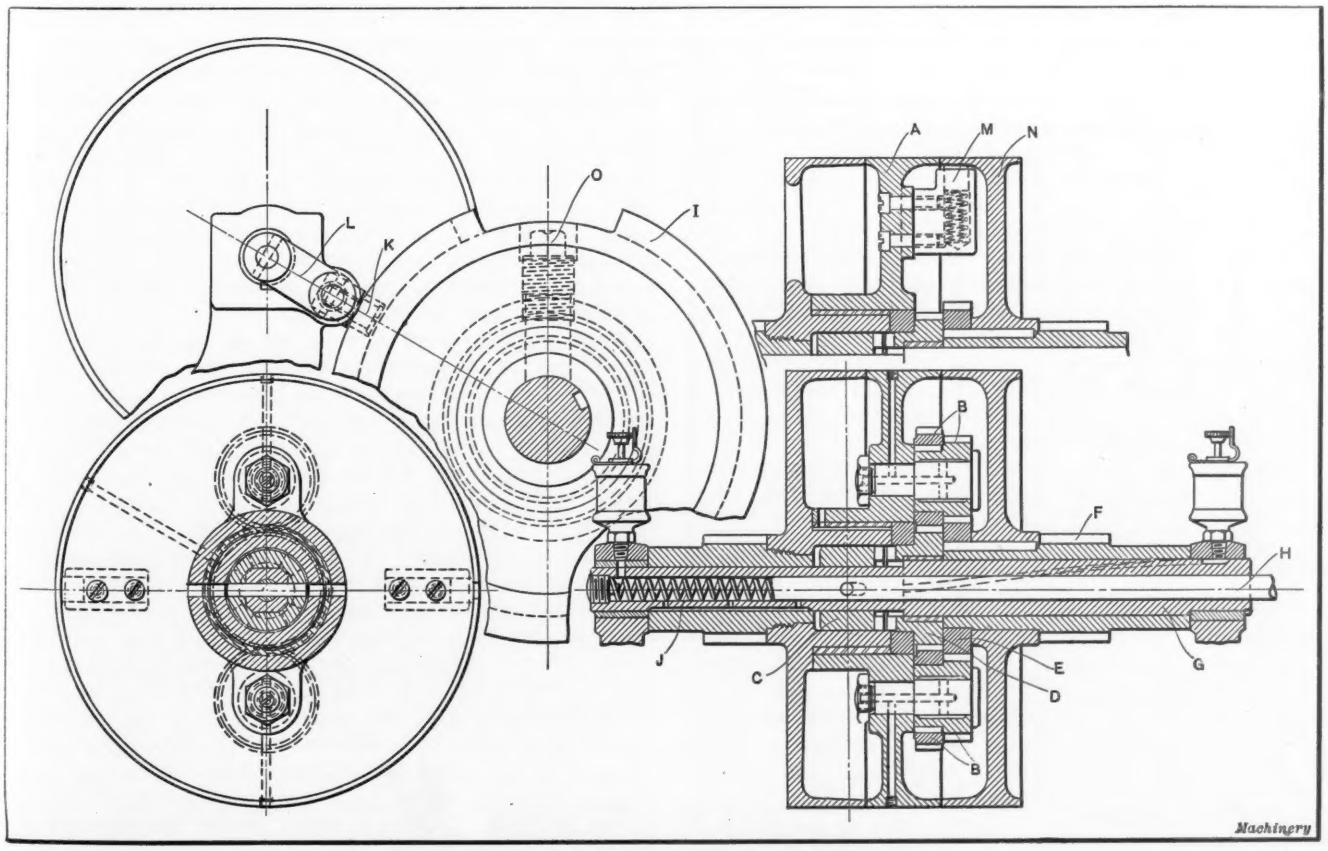
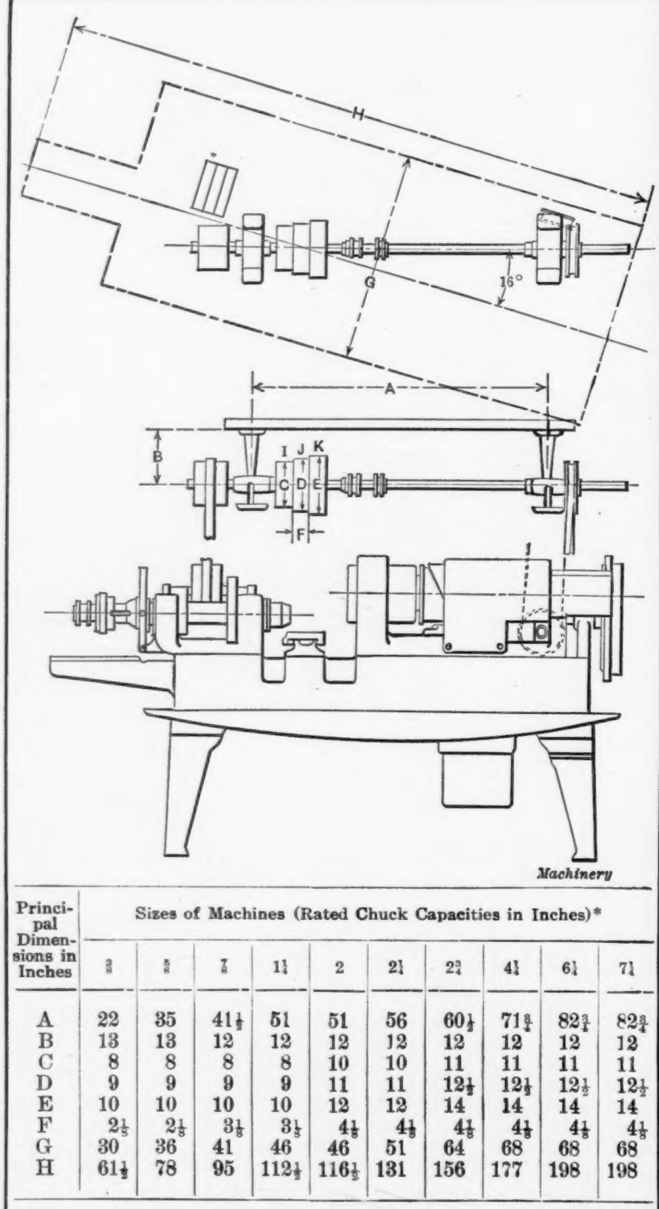


Fig. 19. Detailed Sectional View of Third-speed Spindle Drive

ting up the machine on the same job one or more times, a small attachment G_2, as shown in the illustration, has been provided which consists of a pinion running in the rack teeth in the rod F_3. This conveys a movement to the indicator pointer so that the strip cams on the regulating drum can be set in the proper position if the job has been taken down and is to be set up again. This data, of course, is put on the operation card that goes with the job.

The position of roll Y_2 between the two disks is controlled, as previously explained, by means of the fulcrum lever that receives its movement from the strip cam on the regulating drum. It is therefore evident that a wide range of feed for the turret and cross-slide tools is easily secured, and the

TABLE IV. PRINCIPAL FLOOR AND COUNTERSHAFT DIMENSIONS AND R. P. M. OF CONE STEPS ON COUNTERSHAFT



Principal Dimensions in Inches	Sizes of Machines (Rated Chuck Capacities in Inches)*									
	3/8	5/8	7/8	1 1/4	2	2 1/4	2 3/4	4 1/4	6 1/4	7 1/4
A	22	35	41 1/2	51	51	56	60 1/2	71 3/4	82 3/4	82 3/4
B	13	13	12	12	12	12	12	12	12	12
C	8	8	8	8	10	10	11	11	11	11
D	9	9	9	9	11	11	12 1/2	12 1/2	12 1/2	12 1/2
E	10	10	10	10	12	12	14	14	14	14
F	2 1/8	2 1/8	3 1/8	3 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8
G	30	36	41	46	46	51	64	68	68	68
H	61 1/2	78	95	112 1/2	116 1/2	131	156	177	198	198
	Cone Step Revolutions per Minute									
I	566	533	533	462	450	450	436	436	436	436
J	480	450	450	390	390	390	360	360	360	360
K	410	385	385	330	341	341	300	300	300	300

Machinery

* See Table II.

change in the feed of the tools can be accomplished while the machine is in operation. This is a good feature, especially when setting up a job for the first time. After a job has once been set up, the position of the pointer, as shown in Fig. 15, is indicated on a card and the operator in setting this job up again simply shifts the cams until the pointer comes to the required point on the indicating dial. The regulating drum is driven from the turret shaft by the pinion *P*, Fig. 13, meshing with teeth cut in the rim of the drum.

Construction and Operation of the Cross-slide

On the Cleveland automatic screw machine, as regularly equipped, the cross-slide for holding both the rear and front cutting tools consists of one casting, but a double cross-slide can be supplied when desired. The cross-slide is actuated by means of a fulcrum lever *T* (Fig. 13), which derives motion from cams K_3 on the drum *U* carried on the rear shaft *E*. The flange of this drum is numbered so that the position of the various cams can be recorded on a lay-out card to facilitate resetting the work. As shown in Fig. 11, the cross-slide is provided with an adjustable stop-screw so that accurately formed work can be obtained. It is also provided with adjustable gibs to compensate for wear. The position of the cross-slide relative to the axis of the spindle is controlled by regulating nuts on the connecting-rod fastened to the rear of the slide.

Spindle Capacities and Spindle Drives

Table I gives a list of spindle capacities of the various sizes of Cleveland automatics, for handling round, hexagon and square stock. In this table the sizes for hexagon and square stock are only given to the nearest 1/32 inch corresponding to the diameters of the round bar stock. This, of course, is close enough for all practical purposes. It will be noticed under the column "size of machine in inches" that there are a number of machines having two different spindle capacities. The meaning of this is (referring now to the 5/8—3/4 size) that the machine is the same in both, except for the spindle, which is bored on the enlarged size to take 3/4-inch instead of 5/8-inch bars. This enables work on which there is no extremely heavy cutting to be accomplished to be turned out much more rapidly than it could be on a larger sized machine, because the idle movements take less time.

In order to make the Cleveland automatic adaptable for brass, iron and steel work, it is necessary to provide a variety of spindle drives. Figs. 16, 17 and 19 show the different types of spindle drives that have been devised for handling a large variety of work. Fig. 16 shows the standard drive. Fig. 17 shows what is known as the third-speed attachment; two combinations of this attachment are illustrated, while the last view shows the type of drive particularly adapted to brass work and similar materials.

A detail and sectional view of this third-speed drive is shown in Fig. 19, where its construction can be clearly seen. This attachment is contained within the spindle driving pulleys on the back-shaft of the spindle head. Its purpose is to provide a slow and very powerful speed to the spindle for heavy thread cutting or work of a similar nature, requiring great power in the spindle. The result is obtained by shifting the belt to the center pulley *A* which brings into play the set of hardened steel epicyclic gears *B*. To accomplish this, the sliding clutch *C* is engaged with the gear *D*, and as the clutch slides upon a square shaft and cannot revolve it causes the gears *B* to rotate around the fixed gear *D*, thus driving gear *E* at a very powerful speed. Gear *E* is securely keyed to the sleeve pinion *F* which meshes directly into the front spindle gear of the machine.

When the third-speed drive is not in use, the clutch *C* is moved out of engagement, allowing the entire train of epicyclic gears to be free upon the loose center pulley *A*. The clutch *C* is moved along the shaft *G* by means of the rod *H* controlled by a cam *I*, shown in the end view. This cam moves the rod to the left for disengaging the clutch and the spring *J* moves the clutch to the right for engaging it, when the roll *K* drops off the end of the cam. There are two frictions *M* which serve to keep the center loose pulley *A* driving at the same speed as the pulley *N*, when the third speed is not engaged, so that the planetary pinions will not rotate on the stud at this time. The cam *I* is adjustable around the cam-shaft and is clamped into any desired position by the screw *O* and stud. The lubrication of the entire third-speed attachment with the exception of the planetary pinions is secured by means of a sight-feed oil-cup, while the planetary pinions are lubricated through the oil-hole extending to the rim of the center pulley *A*. The connection between the rod *H* and the cam *I* is link *L* which carries the cam-stud and roll *K*.

Principal Dimensions of Turret, Cross-slides and Miscellaneous Data

Tables II and III and the illustrations accompanying them give all the data pertaining to the turret and cross-slides on the various sizes of Cleveland automatics. By referring to the illustrations, it will be seen that the cross-slide on the various sizes of machines is provided with from one to three slots for holding cross-slide working tools. These are furnished in order to enable the tools to be held in the most convenient position in relation to the work. It is obvious, of course, that on the larger sizes of machines a greater range of positions is necessary than on the smaller sizes. This data will not only be of value to the operator when setting up the machine but will also be of use to designers when devising special tools or the attachments for use on this type of machine.

Principal Dimensions and Set-up Plan

The principal dimensions, capacities, etc., of the various sizes of Cleveland automatic screw machines are given in Table IV. The diagram accompanying this table shows how the Cleveland should be set up to economize on floor space, and in the lower part of this table are given the revolutions of the countershaft when driven from the main lineshaft at the speed recommended.

* * *

METHODS OF STANDARDIZATION BY ENGINEERING SOCIETIES

The ground covered by many societies in standardizing engineering details overlaps in many cases, and it has often occurred that different societies have adopted conflicting standards. It would, therefore, be desirable if some understanding could be arrived at between the societies in order to prevent duplication of work. Prof. F. B. Crocker, of the Crocker-Wheeler Co., Ampere, N. J., has prepared a statement on this subject, from which the following paragraphs are abstracted. Professor Crocker is president of the Electric Power Club and has also been a member of the standardization committee of the American Institute of Electrical Engineers; he is, therefore, in a position to write authoritatively on this subject. Owing to the fact that he is especially interested in electrical work, reference is made particularly to standards in the electrical engineering field, but of course the rules and methods laid down are equally applicable to the standardization work done by any engineering body or society.

Fundamentally there are three broad divisions of standardization—scientific, technical and industrial. As true examples of scientific standards, we have the resistivity and temperature coefficient of copper. A proper matter for technical standardizing is the safe temperature limits of the various kinds of insulating material. As clear cases of industrial standardization may be cited the shaft diameters and speeds of different types and sizes of electric motors. A scientific problem should be handled by the U. S. Bureau of Standards or the American Physical Society. A technical electrical matter should be decided by the American Institute of Electrical Engineers, and an industrial electrical question properly belongs to the National Electric Light Association or the Electric Power Club.

The best way to solve the problems of standardization is not by conferences between a number of bodies acting jointly on the various subjects. Of course cooperation is very desirable in some cases, but in dealing with many matters it is unnecessary. Standardization should be carried on in accordance with the following general scheme: First, each organization should have definite jurisdiction, within which it has full authority; second, each organization should confine its action as far as possible within its own jurisdiction; third, when questions arise that are on the border, or when the authority and interest of two or more organizations overlap, then a conference between the interested parties should be held.

In order to determine jurisdiction, the following plan of procedure may be adopted: When any organization considers it desirable that something should be standardized, its secretary communicates that fact to the secretaries of the other bodies likely to be interested in the same subject. Communication between the standards committees is not sufficient, because there may be several in one society and they may change from year to year. In most cases, from the nature of the particular matter involved, it is clear that it properly belongs to a certain organization, and the others will accordingly acquiesce. In other instances, it is evident that a question is on the boundary between two bodies and they will therefore agree to cooperate in acting upon it. When there is doubt or difference of opinion as to jurisdiction that cannot be settled by correspondence between the parties interested, then the case may be referred to an arbitrator, for example, the director of the U. S. Bureau of Standards, or the president of one of the national engineering societies not interested. The arbitrator merely decides which body or bodies shall have jurisdiction over that subject. The actual standards are determined by this body or bodies.

On account of the very rapid differentiating and specializing in electrical science, technology and industry it would seem that some general plan is needed for present and future standardization. In some cases it is quite evident that a certain body should have sole authority over a certain subject. For example, an organization of men who devote themselves to a particular subject should be able to determine standards for it most correctly and most quickly. Special subjects should be dealt with by those who live with them, so to speak, and devote their thoughts and efforts to them.

In all matters affecting standards it is of the utmost importance to give them very careful consideration. It is much better to have no standard than to have an ill-advised one or to have different standards for the same thing. It is difficult to rectify mistakes of this kind. In looking back over the history of electrical standardization, we see that the tendency has been to standardize too quickly, too often and too much. There have been dozens of wire gages, for example, and electrical books in the English language may use the American, Birmingham or the Standard British gages, each materially different from the other two. Many technical terms have also been introduced that were absolutely unnecessary. Experience, therefore, indicates that we should be conservative in establishing standards. This is another reason why each organization should limit its action to those matters which it best understands; thus fewer mistakes are likely to be made. All standardization committees should be careful not to rush in where angels fear to tread. It is surely a mistake for any organization to reach out and attempt to standardize in any field that does not clearly belong to it. Each organization already has far more that is unquestionably within its province than it can possibly cover, and new ground is being rapidly opened up.

A great deal of trouble is caused to manufacturers and users of machine tools by the varying types, sizes and speeds of electric motors employed to drive them. Hence, the standardizing of motor dimensions for machine tool drive is very desirable. It is solely an industrial matter that should be dealt with by the Electric Power Club and the National Machine Tool Builders' Association acting jointly. Neither the American Institute of Electrical Engineers nor the American Society of Mechanical Engineers should have anything to do with it, because it is clearly outside of their jurisdiction. As a matter of fact, it has been considered by committees of both these bodies. Little has been accomplished, however, because it was thought necessary to consult all four organizations, and everybody's business is nobody's business.

* * *

A German contemporary states that a method has been invented by means of which aluminum may be dissolved so that it may be spread cold over any dry surface and applied like paint with a brush. The appearance of aluminum so deposited is like that of a dull silver coating. It is claimed that this coating is an excellent preventative for rust, that it is durable and resists heat well, and that it can be used as a good substitute for tin-plating.

SPECIAL HOB-TOOTH SHAPES*

METHODS OF DESIGNING AND MAKING SPECIAL HOBS FOR GEARS, RATCHET WHEELS, SPLINED SHAFTS, ETC.

BY JOHN EDGAR†

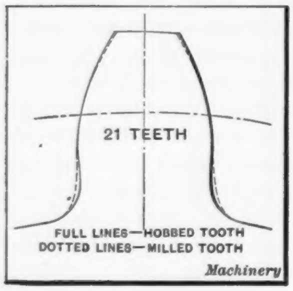


Fig. 1. Comparison between Hobbed and Milled Gear Teeth

THERE is always an objection to changing existing methods in shop practice when the change necessitates discarding established standards and valuable tools and fixtures. Whether such a change will be profitable or not is a question that requires a close study of the conditions in each case. When the change means an improvement in the quality of the product, the cost of the tools and fixtures should, of course, be a secondary consideration. When the question is mainly one of quantity, the problem must be solved on a cost basis only.

Another factor to be considered, however, is that of interchangeability. This is a most important item in the case of a product in connection with which renewals are constantly being made. Many improvements in design and in methods of manufacture are sacrificed in deference to the demands for interchangeability. In the case of gears, interchangeability is supposed to be rigidly adhered to, but while we have a standard which is supposed to produce interchangeable gears, we have so many variations of the standard, due to the secret forms established by different manufacturers of cutters, that it is necessary in many cases to adhere to one make of tools if interchangeability is to be maintained in any degree. Many manufacturers have installed the hobbing machine in the desire to reduce the cost of gearing, only to encounter the non-interchangeability of the product of the hobbing machine with the milled tooth gear; this has been the cause of turning many against the hobbing machine, through no fault of the process itself.

Variations from the True Involute Tooth Shape

The form of the standard tooth, as adopted by the cutter manufacturers, is not the true involute, but an improvised form built around the involute as a basis. The deviation from the involute is necessary for several reasons: 1. The inability of the formed milling cutter to mill an undercut tooth. 2. The necessary alteration in the form of the point of the mating tooth caused by the fullness of the milled tooth below the pitch line. 3. The desire to make the contact

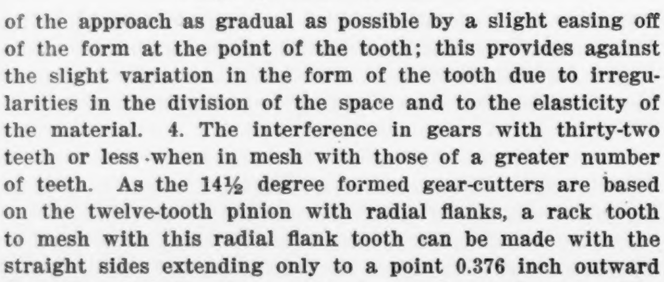


Fig. 2. Hob Tooth designed to generate the Approximate Shape of a 14½-degree Involute Milled Tooth

of the approach as gradual as possible by a slight easing off of the form at the point of the tooth; this provides against the slight variation in the form of the tooth due to irregularities in the division of the space and to the elasticity of the material. 4. The interference in gears with thirty-two teeth or less when in mesh with those of a greater number of teeth. As the 14½ degree formed gear-cutters are based on the twelve-tooth pinion with radial flanks, a rack tooth to mesh with this radial flank tooth can be made with the straight sides extending only to a point 0.376 inch outward from the pitch line in a rack of one diametral pitch. The remainder of the tooth must be eased off from this point outward, sufficiently to clear the radial flank of the pinion tooth. This rounding off of the rack tooth may be made by using the cycloidal curve from the interference point, with a rolling circle of a diameter equal to that of the twelve-tooth pinion. A circular arc tangent to the tooth side, drawn from a center on the pitch line at the point of intersection of the normal to the tooth side at the point of interference, will be a near approximation to the cycloidal curve.

The hobs used extensively today are not made to produce teeth in any near approximation to the shape produced by the milling cutter. The only correction that is made, in many cases, is to make the teeth of the hob a trifle fuller at the base or root to ease the approach; even this is done only in a few instances. The difference between the hobbed tooth and that produced by milling is seen in Fig. 1. The hobbed tooth is shown in full; this shape was traced from an actual hobbed tooth, photographed and enlarged. The gear had twenty-one teeth. The hob used was corrected for the "thin-

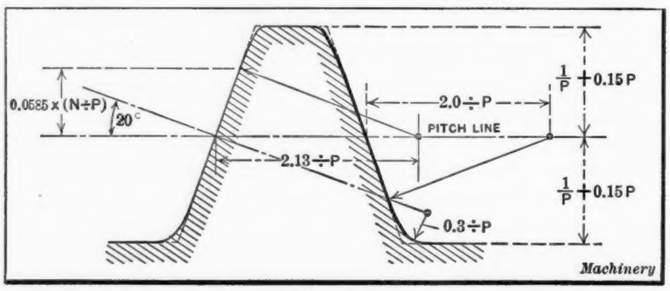


Fig. 3. Hob Tooth for generating a 20-degree Involute Milled Tooth

ning" of the tooth at the point, but in a gear of this diameter the effect would not show to any great extent. The dotted lines are drawn from actual milled tooth curves and show the difference between the two forms of teeth. Attention is called to the fullness of the milled tooth at the root, and the thinning of the tooth at the point. The difference would be greater in the case of a twelve-tooth pinion.

The filling-in of the flank of the tooth is not done to any rule based on a proportion to the number of teeth in the gear. The curve selected is made to fill in the space at the root to just clear the corrected rack tooth. Neither is the thinning of the tooth at the point proportional to the diameter in the sense that the curve of the hobbed tooth is. Each form of the cutter system is made and varied to the extent necessary for smooth action, and the curves of the entire system cannot be produced by the hobbing process with a single hob. To accurately reproduce the form of the milled tooth, a special hob would be necessary for each number of teeth. However, a close approximation may be obtained, within a narrow range of teeth, with a hob generated from a milled tooth. This is being done in the automobile industry with good results. The necessity for interchangeability makes the duplication of the milled tooth imperative when the originals were made with the formed cutter, and the introduction of the hobbing machine, in such cases, depends on the successful duplication of these forms. It is no exceptional thing to see the hobbing process used in conjunction with the automatic gear-cutter in the production of interchangeable transmission and timing gears. The shapes produced by the standard sets of cutters, from a rack to a twelve-tooth pinion, cannot, however, be generated by a single hob, because the shapes are only an approximation of the correct curve. The gears mentioned above as being successfully hobbed are, therefore, when milled, cut with special cutters for each number of teeth, as in this way only can a curve of correct shape be obtained.

As stated above, most hobs are of the straight-sided shape, and the tooth hobbed is of pure involute form. In gears

* For previous articles on this and kindred subjects see MACHINERY, March, 1914, "Hobbing vs. Milling of Gears"; July, 1912, "Hobs for Spur and Spiral Gears," and also articles there referred to.

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of less than thirty-two teeth, the flank is undercut to a considerable extent. This undercutting does not involve any incorrect action in the rolling of the gears, but in the case of the twelve-tooth gear, for example, the involute is cut away at the base line close to the pitch line, giving but a line contact at a point which is subjected to heavy wear. This eventually develops backlash. The teeth of the gears also come into action with a degree of pressure that is continuous throughout the time of contact; this results in a hammering which in time develops into a humming noise.

Special Hobs for Gear Teeth

To overcome these objections a hob tooth may be developed to generate a curve which will closely resemble that of the formed tooth. Such a hob tooth is shown in Fig. 2. Theoretically, the correction for interference or undercutting should begin at a point located above the pitch line a distance as determined for a twelve-tooth pinion by the expression:

$$0.03133 \times \frac{N}{P}$$

in which N = number of teeth in the smallest gear to be hobbed;

P = diametral pitch of gear.

However, to begin the correction for interference at this point would reduce the length of the true involute and result in too full a tooth, causing noisy gears. Therefore, a compromise is made and the correction is obtained for a minimum of twenty-one teeth. To compensate for the extra fullness of the tooth at the root, the point of the tooth is thinned down in proportion, and this is done by leaving the tooth of the hob full below the pitch line by striking an arc from a center on the pitch line, and also employing a large fillet having a radius equal to $0.45 \div P$(see Fig. 2). It will be noticed that the radius of the arc at the top of the hob tooth is smaller than the radius at the bottom of the hob tooth. This will thin the tooth of the gear in excess of the amount necessary to clear the flank, easing the action and eliminating the hammering effect due to the theoretical contact. It will be seen from the illustration that the thinning of the teeth does not affect the twelve-tooth gear to any appreciable extent, but is gradually increased with the number of teeth. The fact that a twelve-tooth gear will mesh without interference at the point of the teeth makes the thinning unnecessary; besides, the small pinions are usually the drivers.

Fig. 3 shows a twenty-degree hob tooth with standard addendum and corrections for non-interference. The curve

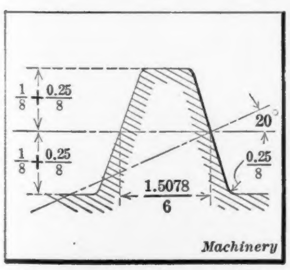

Fig 4. Hob Tooth for a 6/8 Pitch Fellows System Stub Gear Tooth

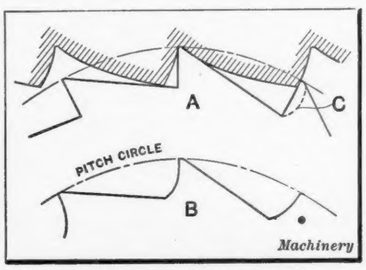

Fig. 5. Diagram showing how Hob may be used for generating Ordinary Ratchet Teeth

of the tooth begins at a point 0.702 inch from the pitch line, in the case of a one diametral pitch tooth, and is based on non-interference with all teeth from twelve teeth up.

Fig. 4 shows the shape of the hob tooth to reproduce the stub teeth of the gears generated on the Fellows gear shaper. The particular tooth in the figure is a 6/8 pitch tooth, and the proportions are given in terms of the pitch numbers so as to be easily applied to the other pitches; thus the height of the tooth above the pitch line is stated as: $\frac{1}{8} + \frac{0.25}{8}$ where 8 is the addendum number of the pitch designation.

The shape of the rack or hob tooth to roll with the gears produced by the gear shaper should be generated from the cutter used. The Fellows cutters have perfect involutes above the base line, with radial flanks, so that the hob tooth would be straight only a distance from the pitch line equal to $0.0585 \times N \div P$, where N is the number of teeth in the cutter; in most cases the cutter would have more than seventeen teeth and the hob tooth would be straight-sided to the point. In this system the radial flank of cutters with more than seventeen teeth does not affect the shape of the face of the tooth, as the involute portion of the cutter tooth generates a pure involute. The straight side of the hob tooth should extend to the root in such cases.

To reproduce gears of some standard the exact shape of which is not known, the hob-tooth shape can be easily generated from the gear tooth on the milling machine, as will be explained in a subsequent part of this article.

Applications of the Hobbing Process

The hobbing process is not limited to the production of gears, but can be used to generate teeth of almost any shape, such as the teeth of ratchets, milling cutters, reamers with equally spaced teeth, chucking drills, multiple splined shafts

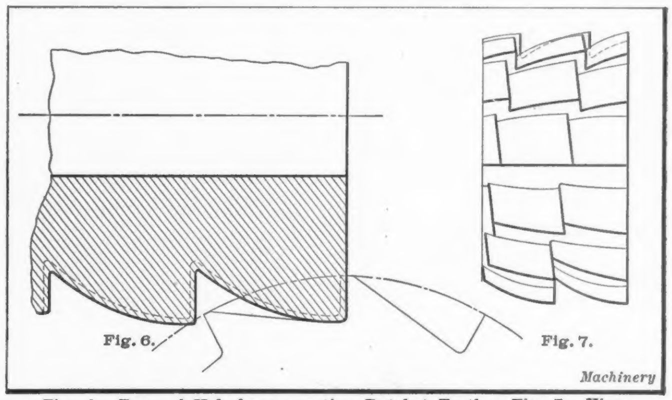

Fig. 6. Type of Hob for generating Ratchet Teeth. Fig. 7. View showing the Relief in the Hob for generating Ratchet Teeth

for automobile transmissions, cams, sprockets, etc. Fig. 5 shows the shape of hob tooth to generate the teeth of ratchets. There is no shape of tooth that will generate the radial teeth of ratchets of the type shown at *A*; the nearest that can be obtained is the modified shape at *B* with the filleted root. Should the tooth of the hob be made straight and normal to the axis of the hob, the tooth produced would be undercut as shown at *C*.

The shape shown is generated from a 12-tooth radial ratchet and would produce a nearer approach to the radial form in ratchets of a larger number of teeth. The back of the teeth would be concave instead of straight in the case of larger numbers of teeth. A good compromise would be to make the back of the hob tooth straighter, the shape being obtained by generating from a ratchet of, say, forty-eight teeth. The back of the teeth of ratchets of a smaller number of teeth would then be convex in shape. Hobs of this kind have been used successfully in hobbing milling cutters, a single hob covering a limited range of sizes. The difficulty in having a hob cover a wide range of cutter sizes is the fact that the pitch of the teeth is not constant, as in the case of gearing. When making cutters in quantities, the cost of the hob is soon covered by the saving in the manufacture of the cutters over the cost of milling. In the case of spiral cutters, the angle can be altered to make it possible to make the hob cover a greater range of sizes. The hobbing process is especially adapted to the making of spiral milling cutters.

The form of hob shown in Fig. 6 is a cross between a hob and a formed milling cutter, and can be employed profitably in the milling of radial teeth by the hobbing process. The form is made with a normal face and is generated back as in the case just shown. The hob is set so as to be all on one side of the center of the blank being cut, as shown. The radial face of the tooth is formed with the face of the hob tooth acting as a fly-cutter, the form of the face being a reproduction of the face of the last hob tooth, which is set radial with the axis of the blank. The fronts of the hob teeth are relieved on the sides; this can be done by using the combined side and radial relief cams, or, if that combination is not available, the side relief can be given as a separate operation. The latter will cause a widening of the top of the tooth as the hob wears back in sharpening. Fig.

7 shows a view of the hob. The convex shape of the generated form of the hob tooth will have the same effect on the shape of the back of the tooth as stated above in the case of the generated hob. This portion of the tooth cannot be made to act as a fly-tool, as it cannot be set on the radial line and must generate the form by a regular generating action.

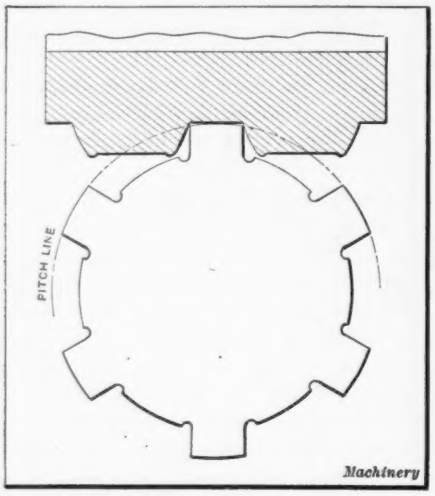

Fig. 8. Hob Tooth for generating a Six-spline Shaft

A form of hob that can be used to advantage in the automobile industry is that for forming the splines on the transmission shaft. This shaft commonly has six splines, as shown in Fig. 8. The face of the splines or teeth have a negative rake, being set ahead of the radial line, and for that reason can be formed with the hob if the depth and thickness are not too great in proportion to the diameter. In the illustration the proportion is six to one, and the hob form is such as to give a very close approximation to the desired form; however, if the shafts are to be used as left by the hob, that is, without grinding, it would be well to make the broach by the same process to insure a duplication of shape in the keyways in the gears. In all these special forms the pitch is taken from the outside of the blank; if taken inside of this point, the hob tooth, if radial, would have to be undercut, which is not practical.

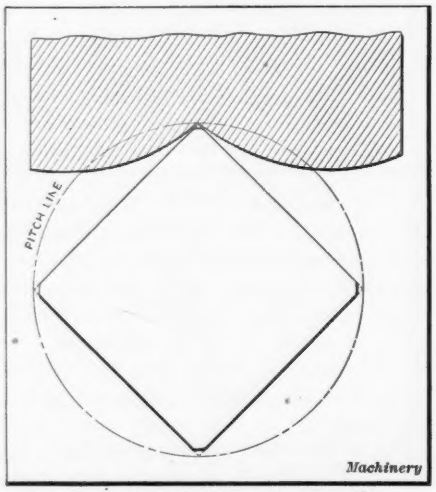

Fig. 9. Hob Tooth Shape for generating Squares

In Fig. 9 is shown another shape that could be used to advantage for hobbing squares. Hobs for this purpose could be used in squaring the ends of such shafts as, for instance, the ends of milling machine feed-screws, cross-screws, and the elevating shafts. If there is a job that is handled to disadvantage on the milling machine, it is the squaring of these shafts and screws. A similar hob could be developed for the hobbing of hexagons and other polygon shapes on the ends of shafts, or for the heads of bolts.

The great disadvantage of the hobbing of the shapes just mentioned is the low number of "teeth" or divisions, which necessitates a rapid travel of the index gear and high ratio gears to give the proper spacing, and also the long lead of the hobs. The latter is not so objectionable in the case of the small squares and hexagons generally used, as the lead in most cases can be lower than one inch.

The examples given do not exhaust the field for the hobbing process, but give an array of cases which are out of the ordinary and show the application of the process to other than the ordinary work of gear-cutting. The shapes have been laid out on the drawing-board in each instance, but a far more accurate way to obtain them is by generating them on the milling machine. This generating process is in reality a duplication of the hobbing process, but in generating the tooth shape for the hob the process is reversed, that is, the shape to be generated by the hob is used in generating the hob-tooth shape.

Generating Hob-tooth Shapes

In Fig. 10 is shown a milling machine set up for generating the hob-tooth templet. This is done on the universal milling machine, or on the plain milling machine if the screw can be connected up with the worm of the dividing head, as in milling spiral work. The spindle of the dividing head is set vertical, and the master gear or templet of the shape it is desired to produce by hobbing is mounted on an arbor in the spindle. In making the master templets, care should be taken to produce the correct shape and to be sure that the shape is true with the hole; if the templet is not true, the shape generated will not be accurate, of course.

[The gearing connecting the feed-screw and the dividing-head must be for a lead equal to the circumference of the pitch circle of the gear from which the hob templet is generated.—Editor.]

To provide a rest on which the tool templet to be laid out may be clamped, a parallel is bolted to the outer arbor support so as to be horizontal and parallel with the milling machine table and at right angles to the machine spindle. The rest may also be in the form of an angle plate clamped to the face of the column, but the former type is the most desirable, as it brings the work in a more accessible position.

The blank templet should be a piece of sheet steel about one-sixteenth inch thick, one edge of which should be straight and true and the surfaces smooth and bright. The surface to be laid out can be given a coat of copper solution, or, still better, varnished so that the lines may be etched deeper, as the handling in working out the shape tends to obliterate the shallow lines in the thin copper coat. This blank templet can then be clamped to the rest in a convenient position. There must be plenty of room for the travel of the gear, so as to obtain the proper amount of "roll" to generate the shape desired. The true edge of the plate should be parallel with the rest and the direction of the movement of the milling machine table. Adjust the knee vertically so that the plate will come up under the gear on the dividing head so as to just clear it; the saddle can then be adjusted across to bring the edge of the plate in line with the end of a tooth in the gear when the center line of the tooth is about at right angles to the axis of the feed-screw as shown in Fig. 11. In this way the templet is set to the proper position for depth. The backlash should be taken up by turning the screw in the direction in which it is to be used.

Now select a tooth space *A*, Fig. 11, as the one to be used in the scribing operation, and run the point of a slim, sharp scriber along the outline of the tooth space, scratching the line on the plate; then move the table about one-half turn of the lead-screw and scribe another line, and repeat the operation until the table has been moved through a length equal to three times the circular pitch. When this has been done the lines on the templet will resemble that in Fig. 12. The lines should now be etched in and the plate polished.

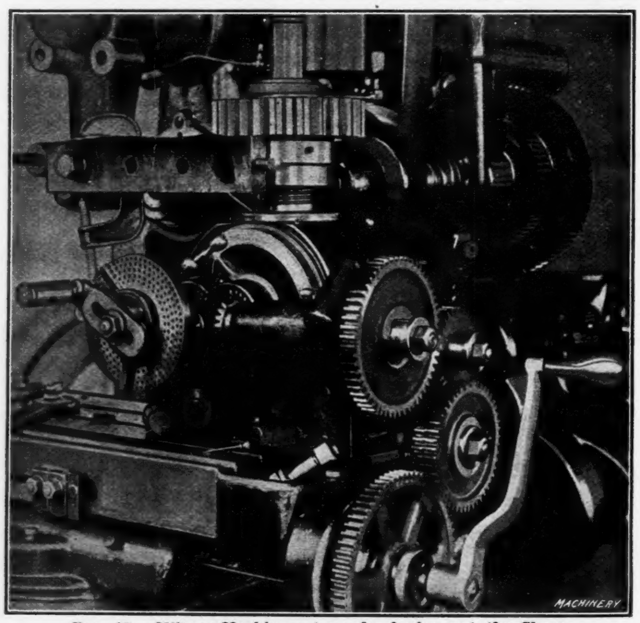

Fig. 10. Milling Machine set up for laying out the Shape of a Hob Tooth

The combined lines on the plate will be seen to describe the rack tooth shape of the hob teeth in a clear-cut manner, if the operation has been carefully carried out. If the gear tooth from which the lines were taken is theoretically correct, the sides of the outline on the plate will be straight a greater portion of the way from the point of the tooth to the edge of the plate; the lines diverge from the straight line at a point near the edge of the plate, as shown by the dotted lines in Fig. 12. This point will be found to be, in the case of the 14½-degree tooth, at a distance from the pitch line of $0.03133 \times N \div P$, where N is the number of teeth in the gear and P the diametral pitch. If the hob to be made from this form is to be used for N teeth or less, the shape of the templet will be correct, but if the hob is to cut gears of a larger number of teeth, the straight portion of the tooth must be carried down to the edge of the plate in order that the teeth of the larger gears will not be cut away too much at the points.

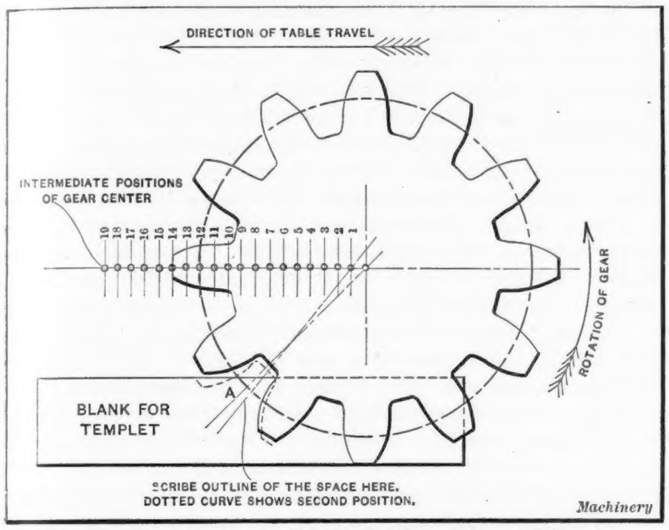

Fig. 11. View showing the Relative Position of Gear and Templet

In making a templet in this way for any other shape than for gears, it should be cut to the lines on the plate, as no correction can be intelligently made in those cases. Some success has been made in the layout of templets for a hob tooth for gears of a limited range of teeth by using the space below the pitch line of the smallest gear in the set and the space above the pitch line of the largest gear in the set as the shape in generating the hob tooth templet. This is of value in generating a hob-tooth shape to reproduce a set of gears milled with formed cutters. However, the best and easiest method is to take the smallest gear in the set as the one from which to generate, and prolong the straight portion of the hob tooth to the edge of the plate, easing the side at A, to point the teeth slightly. The teeth of the hob are generally made with an extra clearance at the bottom as shown. This is a matter on which authorities differ, some preferring to have the hob cut the top of the teeth, to make the teeth of standard length if the blanks should be over size; however, the general practice is to make the tooth the same length both above and below the pitch line as in Figs. 2 and 3.

If the form is for a generated gear and results in the straight-sided tool in Fig. 12, all that is necessary is to measure the angle and make a thread tool that will cut a thread of this section. Should the shape turn out to be a compound of curves, as will be the case in reproducing the milled tooth, the templet should be filed out to the lines, making a female gage to which a planing tool is made, the planing tool being a duplicate of the hob-tooth shape. The threading tool is planed up with this tool. In making the thread tool, it is not usual to make it of female shape, that is, like the templet, but pointed as usual, planing the sides with the opposite sides of the planing tool. The proper corrections should be made in the thread tool to correspond to the angle of the thread, and the setting of the tool and the fluting of the hob, whether it is gashed parallel to the axis or normal to the thread helix.

A master planing tool can be made in the following manner, without the use of the scribed line templet. It is necessary to have a universal milling attachment for the milling machine. The spindle of the attachment is set in the horizontal position with the axis parallel with the direction of the table movement. A fly-tool holder is then placed in the spindle, in which the blank planing tool is to be held. This tool should be roughly formed to the shape to which it is to be finished. The top of the tool should be radial, that is, it should be in the plane of the center of the spindle. The gear or other master templet that it is desired to duplicate by hobbing must be hardened and ground to a cutting edge on one face, preferably the top face when mounted in the spindle of the dividing head, so that the pressure of the cut will be downward. The knee should be adjusted to bring the ground face of the gear to the level of the center of the spindle of the attachment. The dividing head and the table screw are connected in the same way as previously described, but in this case the power feed can be used and the saddle can be fed in to depth as needed, care being taken to use the power feed, in generating the tool, only in one direction, as the backlash in the gears and screw will throw the tool and dividing head out of relative position if used in the opposite direction. As many cuts can be taken as required to obtain a tool of the correct shape.

If the tool is to be used in making more than one threading tool, as might be the case in many instances, the planing tool can be made in the shape of a circular tool which can be ground indefinitely without losing the shape. In this case the fly-tool holder would give place to the standard milling machine arbor. This method is the most accurate way of making the master planing tool, and where the universal milling attachment is available, it should be used where accurate results are desired. It eliminates the human element and the amount of skill required in making the master templet. The inaccuracy of the machine is the only element that is likely to cause error.

One point that is likely to cause difficulty is the relation of the generated tool shape to the thread shape, as it appears in the normal section of the hob tooth. The simple fact is that the master tool shape, as generated by the direct method of making the master planing tool, or the shape as outlined on the hob tooth templet in the first method, is the shape of the cross-section of the hob thread on a plane normal to the hob thread helix. This relation should be kept in mind throughout the process of making the tools and hob. This statement also clears any haziness regarding the question of the lead, as in single-threaded hobs this must be such that the normal pitch of the thread is equal to the circular pitch of the teeth hobbed. In the case of hobs of small thread angles, the normal and axial leads are practically the same, and may be treated as such in cases where the angle is less than 2 degrees and the pitch less than ½ inch; an error of more than 0.00025 inch should not be exceeded in any case. The effect of the error is apparent in the case of a 6 diametral pitch hob 3 inches in diameter, when the axial lead is taken as the circular pitch of the teeth, as it results in an error of more than one-half degree in the pressure angle of the hobbed tooth. Only in extreme cases should the angle of the hob thread be more than ten degrees.

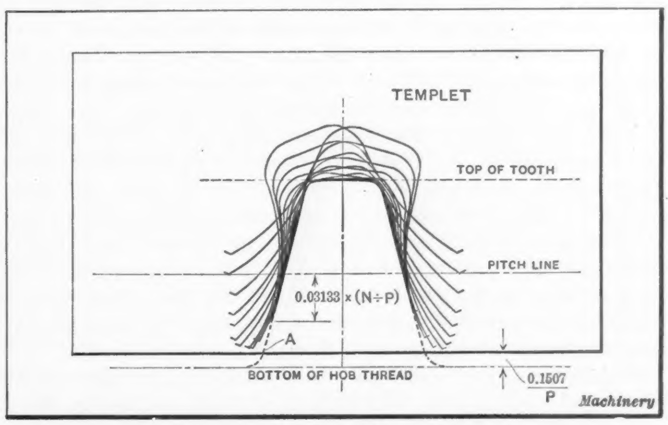

Fig. 12. Lines scribed on the Hob Tooth Templet from a Hobbed Gear

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WHY A MAN IS PROMOTED

Anyone who has worked in a machine shop is familiar with expressions such as this: "They made him foreman of the tool-room and yet he is not much of a toolmaker. Why, he couldn't turn out the kind of work that Jim Higgins can do; he couldn't begin to touch it." Thus his fellow-workers judge the new foreman's ability as foreman only from the point of view of his manual skill, forgetting entirely that a good foreman must have other qualifications besides skill in his trade. To be a good toolmaker is very desirable for a tool-room foreman, but it by no means follows that every good toolmaker will make a good foreman. In fact, the most skillful toolmakers are likely to make the least successful foremen, for the reason that their development has been altogether along lines of skill in their trade, and other qualifications have remained dormant. A foreman should have executive ability, good judgment, a knowledge of men, and tact; and if he has a fair proportion of these qualifications, he can get along with a comparatively meager toolmaking ability. He is not supposed to *make* the tools; he is supposed to know *how* to make them, and it is a curious fact that people whose hands are not very skilled in doing certain work often possess the ability to tell others how to do it.

The same also holds true in regard to positions above that of foreman. The superintendent need not always be a man versed in all the details of the operations performed in the shop. The more he knows about the details the better, of course, but if his foremen are of the right type, they should be depended upon to look after details. His work should be of a general supervisory and advisory character. He should not be burdened with detail, but should be left free to get a good perspective view of the work in the whole factory; to see that all the departments work in cooperation; that harmonious relations exist; that the methods used are the most modern; that nothing is permitted to get into a rut; that causes for friction between employer and employe are adjusted; that the capacity of the plant is suited to the demands on it; that there is no waste of labor due to inefficient methods; and that systems are not being worked for system's sake. If he is able to look after all of these things efficiently, he will make a pretty good superintendent, even if he should happen to lack information on some of the details relating to the work in camming up an automatic screw machine.

STANDARDIZING ENGINEERING DATA

The confusion that exists in the engineering trades, due to the lack of a standard for straight pipe taps, has caused much trouble to firms making and using taps and dies for producing this class of threads. The various manufacturers of dies and taps each have tables by which these tools are made, and taps, dies and gages bought from different manufacturers differ slightly in their diametral dimensions. In one case a manufacturer threaded three thousand valve stems with dies obtained from one maker, and upon comparing them with a gage obtained from another, found considerable discrepancy in the dimensions.

The American Society of Mechanical Engineers is endeavoring to do some work toward establishing standards, but the methods of doing the work so far adopted are inadequate to produce the results which the engineering world has a right to expect from an association of its reputation. To accomplish the desired results the society should concentrate more on work looking toward standardization of engineering data; there is no field in which more useful work can be done. It is hardly possible, however, for a large engineering society to carry out work of this kind simply by forming committees of members who receive no compensation for their work and give only their spare time to it. Such work must be carried forward in a systematic manner by picked men who are paid for their time, and the society would be warranted in using a portion of its funds for this purpose.

We think the watchword of an engineering society should be "efficiency"; but the efficiency of a society is not apparent unless it can point to some constructive and useful work having been performed, not merely by individual members, but by the society as a body.

* * *

HOLDING FAST TO THE GOOD

During the past few years there has been much said in regard to the narrow guide on machine tools. The narrow guide is undoubtedly an advantageous feature of machine design, whether applied to machine tools or any other type of machinery requiring slides to move in a rectilinear path with a minimum of friction and wear. The binding action of comparatively short slides in wide guides is well illustrated in the drawers of wide furniture, and someone has referred to it as the "bureau drawer" effect—a very expressive term.

The revival of the narrow guide in American machine tool design—for a revival it is—is an illustration of how valuable ideas are sometimes employed and then discarded for no apparently good reason. They seem to fall out of sight. As an illustration, the Gleason gear planer of the former type was built in 1876 with a narrow guide for the housing, but in later designs this admirable feature was not used. The value of the feature was apparently lost sight of for a number of years, when it was revived in the designs now being built.

It is important to originate and progress, but it is equally important to hold onto that which has been proved good. The principle applies not only to machine building, but to every activity of life.

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THE POLICY OF SECRECY

It is hardly conceivable that there are no standard dimensions for so simple a thing as a nut for a 3/16-inch bolt. Yet it appears that no dimensions for nut diameters smaller than ¼ inch have ever been standardized, and it is practically impossible to obtain from manufacturers of nuts any tables giving dimensions for these sizes. In an endeavor to amplify the data we have published relative to standard dimensions of bolts and nuts, we tried to obtain from a number of manufacturers the dimensions used in making this class of nuts; but in all instances the replies were evasive, and we were unable to obtain a list of dimensions for small nuts, although tens of thousands are manufactured annually, and the manufacturers must have some tables or data from which to work. Of course, there is no generally recognized standard for these small machine details, but if manufacturers were not so reluctant above giving out information when secrecy cannot be of the slightest advantage, it would be possible to establish a standard.

Our readers frequently write us asking why we have not published information on this or that subject. To most of these inquiries we must answer that the manufacturers, even of articles which can be bought in the open market and measured, on account of some narrow policy, refuse to give out information which will make it possible to place on record the required data.

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SOME POSSIBILITIES OF MOVING PICTURES

The general possibilities of moving pictures in the industries have been discussed in MACHINERY from time to time, but being a fruitful field we shall undoubtedly have occasion to refer to them frequently in the future. Like many other inventions, the moving picture has been applied to uses not thought of by the originators. The spread of the moving picture theater has been astonishing, and nearly every small town has at least one in operation. The capital investment in these enterprises and in the manufacture of films and machines is enormous. The large profit in the business makes possible more rapid developments than in other lines.

One interesting development is showing the pictures of lost men and women on the screen of theaters all over the country. If these persons are alive the probability of identification is greatly multiplied as compared with the means commonly used. Another development is the dissemination of pictorial news which is shown to thousands, thus spreading knowledge of places, men, historical pageants and notable events more vividly than can be done by the newspapers.

The uses that will be made of moving pictures in the machinery industry have hardly been touched, although their application in marketing machinery is beginning to be appreciated by some manufacturers. That they will become a most important factor in marketing many products is evident to those who have studied the subject.

An aspect of the moving picture which has received little attention so far is the possibility of making drawings "alive." The drawing of a machine can be understood only by a mechanically trained mind, and to one who is not familiar with mechanical drawing an ordinary blueprint means little. Even the trained mechanic experiences some difficulty in imagining all the relations of the parts when in operation, especially if the movements are at all complicated.

The moving picture affords the means of building machinery in the drafting-room—machinery that will "run" and show the functions of the various parts. To secure such results means making many drawings, sufficient to illustrate a complete cycle as observed from any desired viewpoint. Moving pictures requiring several thousand drawings to illustrate the humorous conceptions of famous caricaturists have been successfully produced, the illusion being perfect.

The moving picture has been applied lately to the demonstration of automatic machinery before the patent courts. Few jurors are mechanical men, and it is difficult for them to grasp the principles of operation of automatic machinery, such as is used for making shoes, for example. Recently the moving picture of an automatic shoe machine in full operation was made use of to illustrate its action to a court with great success.

The value of moving pictures is limited as yet in teaching trades, and it is difficult to show clearly the operations of machines on account of intervening parts. In the latter case, the natural position of an operator at work, between his machine and the camera, also interferes with the photographer. In automatic machine work opaque objects may sometimes be replaced by glass parts through which the other parts can be photographed. The operation of pumps for students studying physics and some other operations have been shown in this way, and undoubtedly other developments will be worked out to facilitate the use of moving pictures for such purposes.

To the scientific manager, the possibility of doing experimental work on paper instead of using costly iron and steel will appeal strongly. It will be done cheaper, quicker and more quietly; and if successful, the films will be useful as a means of demonstrating the action to prospective buyers.

STEEL DRIVING BELTS

In a paper on steel-belt power transmission read before the Textile Institute of Manchester, England, February 24, the following information, not previously published, is contained.

A great many of the Lancashire textile mills that in the past have used rope drives are now equipped with steel driving belts. One of the most important advantages of the steel driving belt is the small percentage of loss of power in the power transmission. It has been thought, in general, that steel belts could be used only for comparatively light powers, but, at the present time, there are steel belt drives installed transmitting all the way from 10 to 3650 horsepower. The steel belts—manufactured by the Eloesser Kraftband Gesellschaft, Charlottenburg, Germany— are made from a charcoal steel hardened by a process which is kept secret by the manufacturers. The finished material has a tensile strength of 190,000 pounds per square inch. Owing to its great strength, the belt never need be stretched above its elastic limit, and, hence, the length of the belt is constant and no subsequent adjustment is required. The thickness of the belts varies, but never exceeds 0.040 inch. The widths used at present vary from 1½ to 8 inches, according to the working conditions and the maximum horsepower to be transmitted.

The ends of the belt are joined by a steel joint, so designed that it can be bent to the shape of the pulley when passing around it. The rims of the pulleys in present-day installations are covered with a layer of canvas to which is glued thin sheets of cork that are in contact with the steel belt.

During comparative tests carried out in Germany, and officially confirmed by the German government, it was found that a mill using five rope drives consumed 342 horsepower. When these drives were changed to steel belts the horsepower required was 318. In another case, where rope driving required 643 horsepower, steel belt drives, under similar conditions, consumed but 581 horsepower. At an English spinning mill the average power required with rope drives during a period of two weeks was 1020 horsepower, while with steel belts it was not more than 900 horsepower. Smaller installations have shown even a greater proportion of saving in the power losses.

The following details are given of the comparative cost of steel belting, leather belts and ropes, and also of the comparative size of steel belts required to replace cotton rope drives. In a case where 300 horsepower was transmitted at 250 revolutions per minute, the total cost of a rope drive installation was $1200. With leather belts the cost of installation would be practically the same, while with steel belts the total cost would not be more than $900. It is further stated that the power loss with rope drives would be 6 per cent; with leather belts, 4 per cent; and with steel belts, only ½ per cent. A steel belt 8 inches wide will take the place of eight cotton ropes 2 inches in diameter, or of a double leather belt 22 inches in width. In other instances, an 8-inch belt has been used to replace ten 2-inch ropes, and four 6-inch steel belts have been used to replace twenty-two 2-inch ropes, the horsepower required in the latter case being 900. Experiments made at the Charlottenburg Technical Institute, Germany, indicate that the coefficient of friction between the steel belts and the covered pulley is 0.27. A considerable number of rolling mills have adopted steel-belt drives in Germany.

While there is the advantage that the weight of steel belts is only about one-sixth of the weight of leather belts or ropes suitable for transmitting the same power, and while there seems to be no practical limit to the speed at which they can be run, there are also some disadvantages. So far, it has not been found feasible to use steel belts with fast and loose pulleys on account of the difficulty of shifting; neither are they adapted for cross belts where the distance between the centers of the pulleys is less than eighty times the width of the belt. They are not suitable to be run over very small pulleys on account of the severe bending stresses set up in the steel. In Great Britain this belt is handled by the Power Pulley Co., Ltd., Manchester. This concern claims excellent results from the installation in large cotton mills in the Manchester district.

BORING AND REAMING AUTOMOBILE ENGINE CYLINDERS

The method of machining automobile engine cylinders varies to a considerable extent throughout the automobile industry. In some plants they are rough-bored in a cylinder boring machine and finished by grinding. This is considered by many manufacturers to be the most practical method of finishing a cylinder that has a blind end. However, on engine cylinders of the T-head type where boring-bars having leaders can be used, the method of finishing the bore by boring and reaming is quite generally used. The Sterling Motor Co., Detroit, Mich., uses a Beaman & Smith cylinder boring machine, as illustrated in Fig. 1, and completes the cylinder bores in this machine by boring and reaming.

The bore is machined to the correct size in three cuts. A roughing cut, as shown in the set-up in Fig. 2, is first taken. Boring-bars having leaders that are guided by bushings in the lower part of the jig carry Kelly boring cutters, a better and closer view of which appears in Fig. 3. In the first cut, about ¼ inch is removed from the diameter of the cylinder

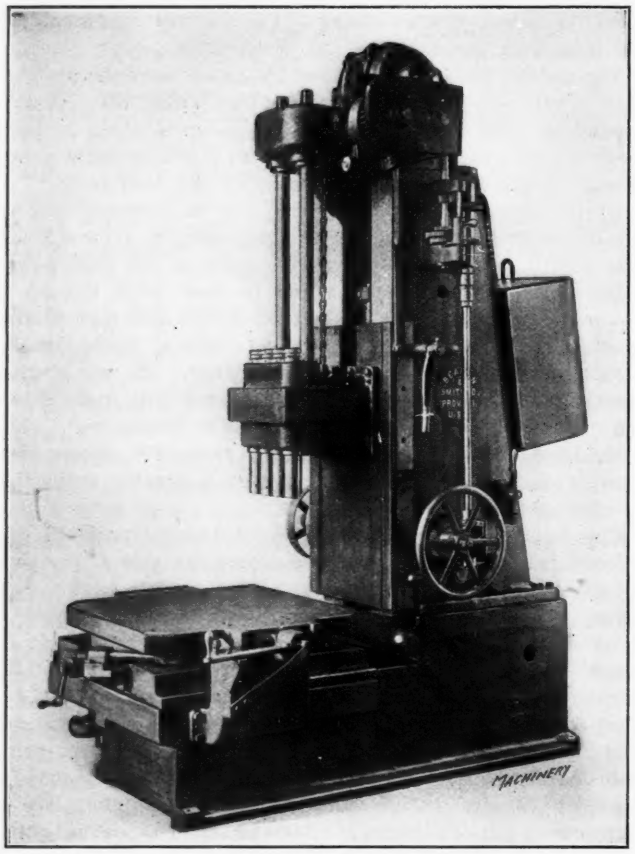

Fig. 1. Beaman & Smith Cylinder Boring Machine used for boring and reaming Engine Cylinders

bore; then the cylinders are annealed, after which they are brought back to the cylinder boring machine and two cuts taken, a finish-boring and a reaming cut. For the final boring and reaming operation a Kelly combination boring and reaming tool is used. This tool is arranged with the boring tool located ahead of the reamer, but set back to leave about 0.010 inch to be removed from the diameter of the cylinder bore by the reamers that follow. It is thus possible to take two cuts in one down travel of the head of the boring machine.

Referring to Fig. 1 it will be seen that the cylinder boring machine has a table of square section on which the work-holding fixture is held. This table is provided with two indexing points, so that a fixture which is capable of handling two pieces of work at the same time can be operated very economically. Fig. 2 shows a closer view of the fixture and gives a good idea of its construction. It will be seen that two castings are held in the fixture by means of swinging clamping straps, which also retain screws for holding the top portion of the cylinder rigidly in position. By having a table that can be indexed, it is possible to be operating the machine while removing and loading the other station on the fixture, so that the machine is kept in practically continuous

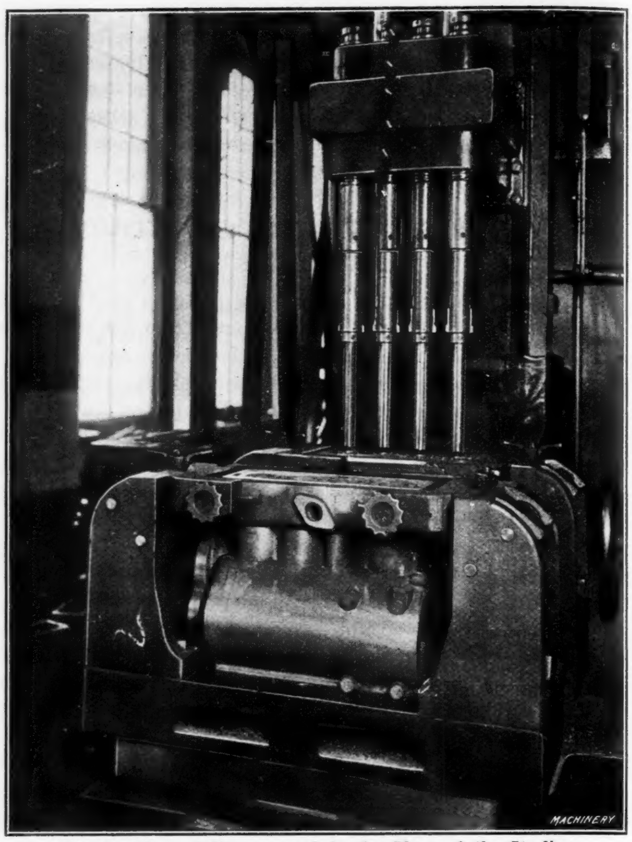

Fig. 2. Type of Fixture used in the Plant of the Sterling Motor Co., Detroit, Mich., for holding Four Cylinder Castings while boring and reaming

operation. This provides a very economical means of operating and greatly increases production. The finished dimensions of the cylinder illustrated are 2¾ inches diameter by 6¾ inches depth of bore, and a production of forty completed castings or 160 cylinder bores is obtained in ten hours.

D. T. H.

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The lock-gate sills of the Panama Canal are all made from "greenheart," which is a large tree found in the dense jungles of northern South America, especially in British Guiana. The wood will bear, without crushing, a weight of six tons to the square inch, and will remain sound 100 years under water; it is immune to the attacks of the salt water teredo.

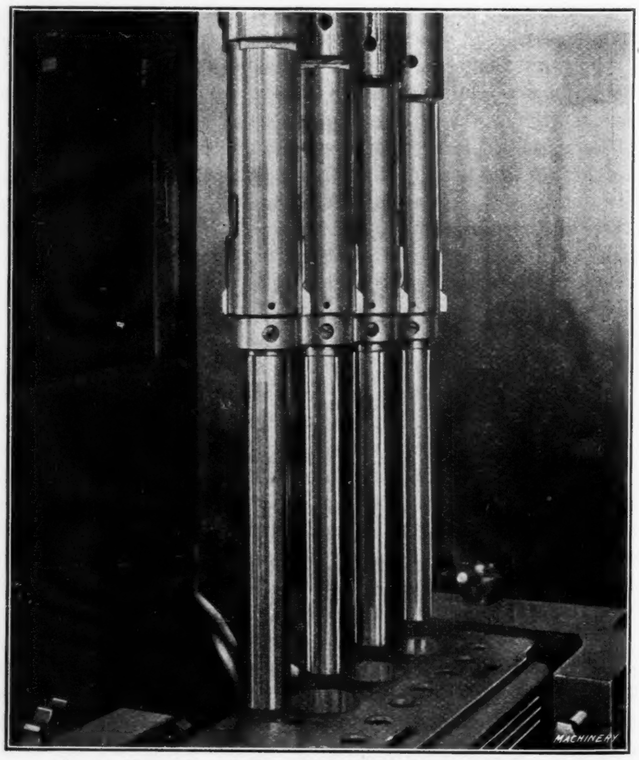

Fig. 3. Close View of the Kelly Boring Tools used for roughing out the Cylinder Bore

GAS AND OIL FIRED FURNACES FOR HEATING STEEL

TYPES OF FURNACES USED, AND IMPORTANT FEATURES OF THEIR CONSTRUCTION

BY E. F. LAKE*

IN the last decade many improvements have been made in furnaces in which steel is heated, to obtain greater accuracy and uniformity in the temperatures. Only a few years ago any temperature that was above that at which steel would harden and below that at which it would become burnt was considered good enough. In most steels this would cover a range of something like 300 degrees F. Recent investigation, however, has shown that only a few degrees of variation in temperature between these two points makes considerable difference in the hardness, the elastic limit, the reduction of area, or the longevity of steel, as shown by fatigue tests. For instance, to heat steel 50 degrees above the transformation or critical point, or the point at which it should be quenched for hardening, shows a loss of something like 15 per cent in these physical properties; and greater variations show correspondingly greater losses. Thus, while large furnaces formerly had a variation of some 50 to 100 degrees in different parts of the heating chamber, the modern furnace must be so designed that the temperature will not vary more than 10 degrees between any two places, when the furnaces are operated at temperatures that are between 1400 and 1800 degrees F.

The interior construction of the furnaces has, therefore, been changed; appliances for pre-heating the fuel have been devised; gas and oil burners have been improved; automatic heat control instruments have been attached; and heat measuring instruments of various kinds have been brought into use to register and record the temperatures. Other improvements have also been made to reduce the fuel consumption; considerable study has been devoted to this part of furnace design.

The consumption of fuels has been studied by the Bureau of Mines, at Washington, D. C. One of the things conclusively proved is that a solid wall is better than a hollow wall, especially if the air space is near the outer side of the furnace. The general belief has been that air spaces built into the walls of a furnace would greatly reduce the amount of heat that was dissipated through the walls. The investigation mentioned proved, however, that while heat would travel slowly through air, because it is a poor conductor, the heat would readily leap the air space by radiation, and thus a considerable percentage was lost that could have been saved if the air space had been filled with some solid non-conductor of heat.

These results caused the Industrial Furnace Co., of Detroit, to design and build furnaces in the manner shown in Fig. 1. In these *A* is the cast-iron shell or outer wall of the furnace; *B* is mineral wool, or asbestos, used as a heating insulator; its thickness varies from 2 to 4 inches according to the size of the furnace; *C* is the inner fire-brick wall of the furnace; and *D*, the fire-brick floor. The burners are located at *E*, and the arrow heads show the direction in which the flames and hot gases circulate. After passing through the heating chamber and giving up their heat, the spent gases pass through the vents *V*. At *F* is a sliding door that is typical of such furnaces, and at *G* the peep-hole in the door, while *H* is a shelf in front of the furnace.

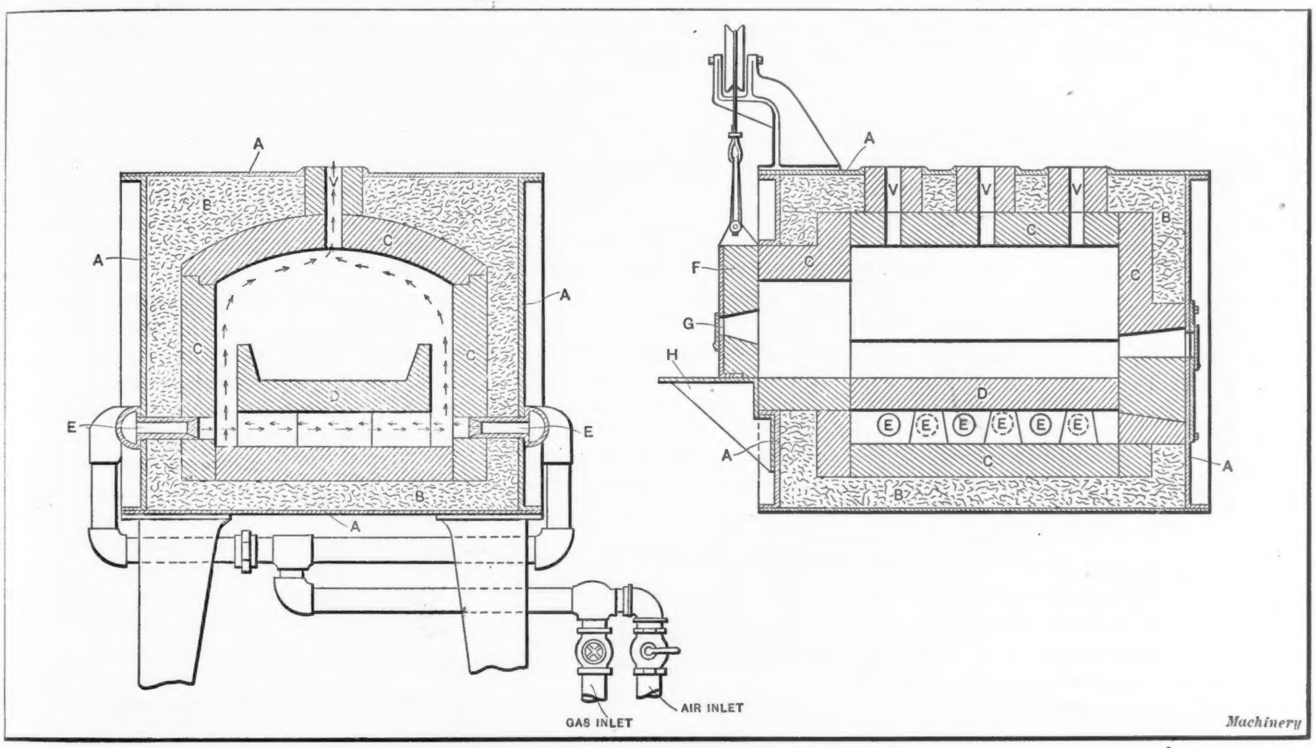

Fig. 1. Heating Furnace heavily lined with Asbestos to retain the Heat

Another method of economizing fuel is shown in Fig. 2. Here the Industrial Furnace Co. has taken two furnaces, similar to the one shown in Fig. 1, and provided a conduit connecting the side of one with the bottom of the other. This conduit is lined with asbestos and fire-brick, the same as the furnace, and can be taken off at any time, so that the furnaces may be used as separate units. In this twin furnace harrow springs are inserted in furnace *I*, to the left, and heated to the correct hardening temperature which is here maintained. After the gases have done their work in furnace *I*, they pass through conduit *J* to furnace *K*, at the right, and heat this to the correct temperature for drawing the temper of the springs. Thus the heat from the fuel is used the second time before it is allowed to escape to the atmosphere. In long furnaces several conduits are necessary to distribute the heat and make the temperature uniform in all parts of the heating chamber. The conduits should then be provided with dampers, so that the heat can easily be controlled. With only one conduit, however, the temperature within the heating chamber of the tempering furnace can be controlled by opening and closing the vent hole.

The same principle has been used by the Garrett-Tilley Furnace Co., of New York, in a three-chambered furnace,

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each part of which is maintained at a different temperature. This is built in a single unit as shown in Fig. 3; that is, the three different heating chambers are built inside of one furnace shell. In one instance this type of furnace has been used for manufacturing leaf springs. In that case, the heating chamber *L* is used to heat the spring plates to the fabricating heat, which is about 1800 degrees F. When taken from this fire the plates are bent to the correct shape to fit the leaf below, on which they have their bearing. After that they are inserted in the middle furnace or heating chamber *M*, to be heated to the hardening temperature, which is around 1500 degrees F. When heated to this temperature they are taken from furnace *M* and quenched in oil. After that they are inserted in the furnace or heating chamber *N*, and heated to the drawing temperature, which is about 750 degrees F. This allows an accurate control of the temperature in the three separate heating chambers, and each is maintained all day at its respective temperature of 1800, 1500, and 750 degrees F. In this case fuel oil is used for heating the furnace, and pyrometers are used to measure the heat in each oven, so that the temperature can be kept at the correct point.

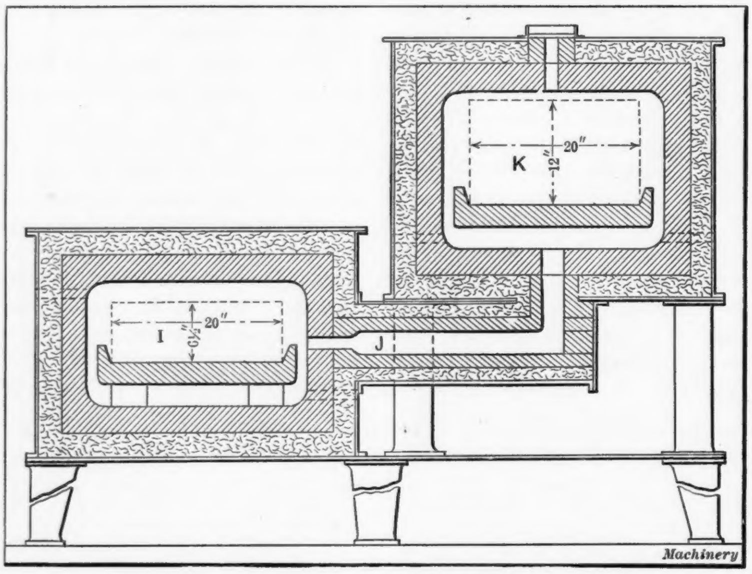

Fig. 2. Twin Furnace connected with a Conduit in order to make Use of the Heated Combustion Gases Twice

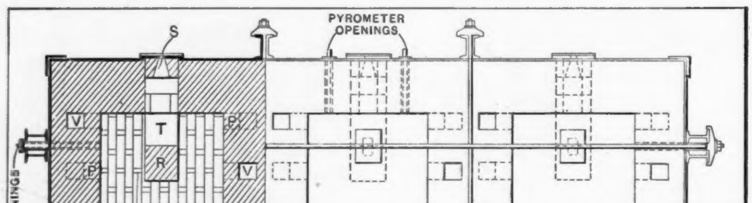

Fig. 3. Over-fired Furnace containing Three Heating Chambers arranged for Accurate Heat Control

The heating chambers in this furnace are about six feet in length, and it is especially designed to give a uniform temperature in all parts. On the test run the variation between any two places in each of the heating chambers was shown to be less than 10 degrees. This accuracy was obtained by over-firing and passing the heat through a honeycombed arch over the heating chamber, as shown by the sectional view at *O* in furnace *L*. This arch separates the combustion chamber *W* from the heating chamber *L*. The burners are located at *S* and the flames enter the furnace at *T* where they strike a baffle plate *R*. This distributes them to both sides of the heating chamber. After filling the heating chamber, the hot gases pass through the openings in the honeycombed arch, as shown at *U*, and heat the oven in which the work is placed. The spent gases then leave the heating chamber through ports *P*, pass underneath the floor of the furnace and up through the vents *V*. Thus the top, sides and bottom of the heating chamber are kept at the same temperature throughout its entire length. This over-fired principle has been applied to furnaces with a single heating chamber as well as to those that have two and three heating chambers, and has proved very successful.

Still another improvement in oil fired furnaces was recently patented by Walter S. Rockwell of the Rockwell Co., New York. This is shown in Fig. 4. It consists of a pipe coil through which the air is passed and pre-heated before it reaches the burners, where it is mixed with the fuel oil. This pre-heating coil *A* is located in front of the furnace, directly over door *B*, where it receives the heat which comes through the opening in which the work is inserted into the furnace. The plate *C* in front of the coil serves the purpose of protecting the furnace operator from the heat which comes through door opening *B*. One of these furnaces has been used by the Detroit-Timken Axle Co. for some time; it is claimed that the fuel consumption has been reduced by more than twenty-five per cent over that of furnaces that do not preheat the air. All or part of the waste gases can be made to pass through the door opening instead of through vents, and thus pre-heat the air to any desired degree.

The air for combustion enters the coil, under pressure from a pump, through pipe *D*, which is provided with valve *E* to regulate this pressure, so that the air and fuel oil will have the proper mixture. The heated air leaves the coil through pipes *F* and enters burners *H*, where it is mixed with the fuel oil which flows to the burners through pipes *I*, its rate of flow being controlled by valves *K*. The blast of hot gases then passes from burners *H* into heating chamber *L* to raise it to the correct temperature, and out through door *B* to heat the air in coil *A*.

Oil and gas fired furnaces are a great improvement over those that are fired with coal and coke, as with the latter it is impossible to keep the temperature in the furnace at a given point, and much of the heat is lost through the chimney which must be provided to carry away the smoke and gases. A large part of the furnace operator's time is taken up in shoveling in the coal or coke and carrying away the

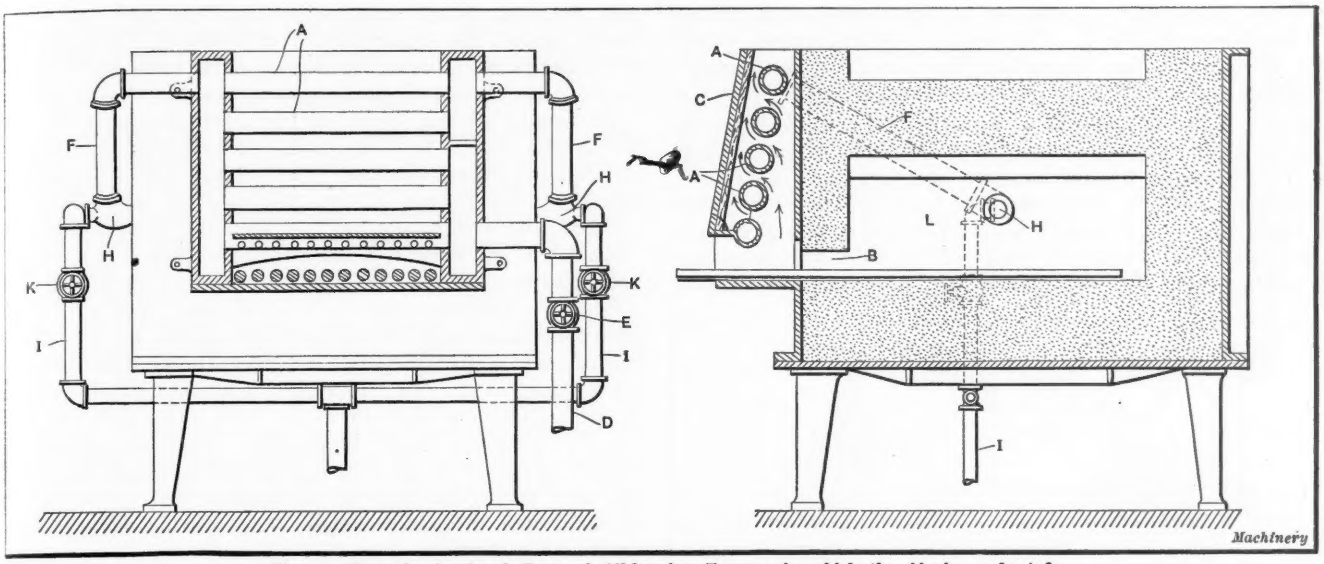

Fig. 4. Recently developed Type of Oil-burning Furnace in which the Air is pre-heated

ashes, while the dust and dirt that accumulates from these operations is, to say the least, very disagreeable. Then again the steels heated in such furnaces are more liable to oxidize and scale, and to absorb some of the sulphur or other injurious elements that arise from the combustion. It is a well known fact that steel absorbs such impurities more readily when heated to the high temperatures required for hardening, forging and welding. For these reasons, furnaces using liquid fuels or gas have improved the quality of metal heated in them, effected a considerable saving in fuel consumption, and saved time by allowing the operator to give more of his attention to the heating of the metal. They have also effected a big improvement in the cleanliness of rooms in which furnaces are located.

When gas and oil furnaces were first installed, a 50-degree variation in the temperature during a day's run or in different parts of the furnace was considered quite good performance, but recent improvements have brought this to a point where a 10-degree variation is all that is allowed in high-class furnaces. This has made it possible to heat-treat steels at more accurate predetermined temperatures, and thus give them greater strength and resistance to fatigue.

One of the greatest improvements that has been made for controlling the heat in the gas furnace is the temperature control instrument that is manufactured and attached to furnaces by the American Gas Furnace Co. This automatically increases and reduces the amount of gas and air that enters the burners, and hence raises and lowers the flame that enters the furnace. It is operated by a mechanism that is attached to the pyrometer. By means of a diaphragm this mechanism raises and lowers a sleeve containing gas and air ports, and thus increases or reduces the size of the port openings. With this instrument the heat inside the furnace can be kept within five degrees of the point at which the instrument is set, and the temperature can be maintained within this narrow limit as long as the gas and air blast keeps flowing into the furnace. The oil-burning furnace must be regulated by an adjustment of the oil and air valves by the furnace operator, as no instrument has yet been perfected that will do this automatically. Several individuals are working on this problem, however, and seem to have arrived at a solution. Thus it will probably be but a short time before a similar instrument will be devised for automatically controlling the temperatures in furnaces using oil for fuel.

Many improvements have also been made in oil- and gas-burning furnaces that heat liquid baths for raising the temperature of steel to the hardening temperatures. One of the improvements made in an oil-burning furnace is shown in Fig. 5. This was designed by W. S. Quigley of the Quigley

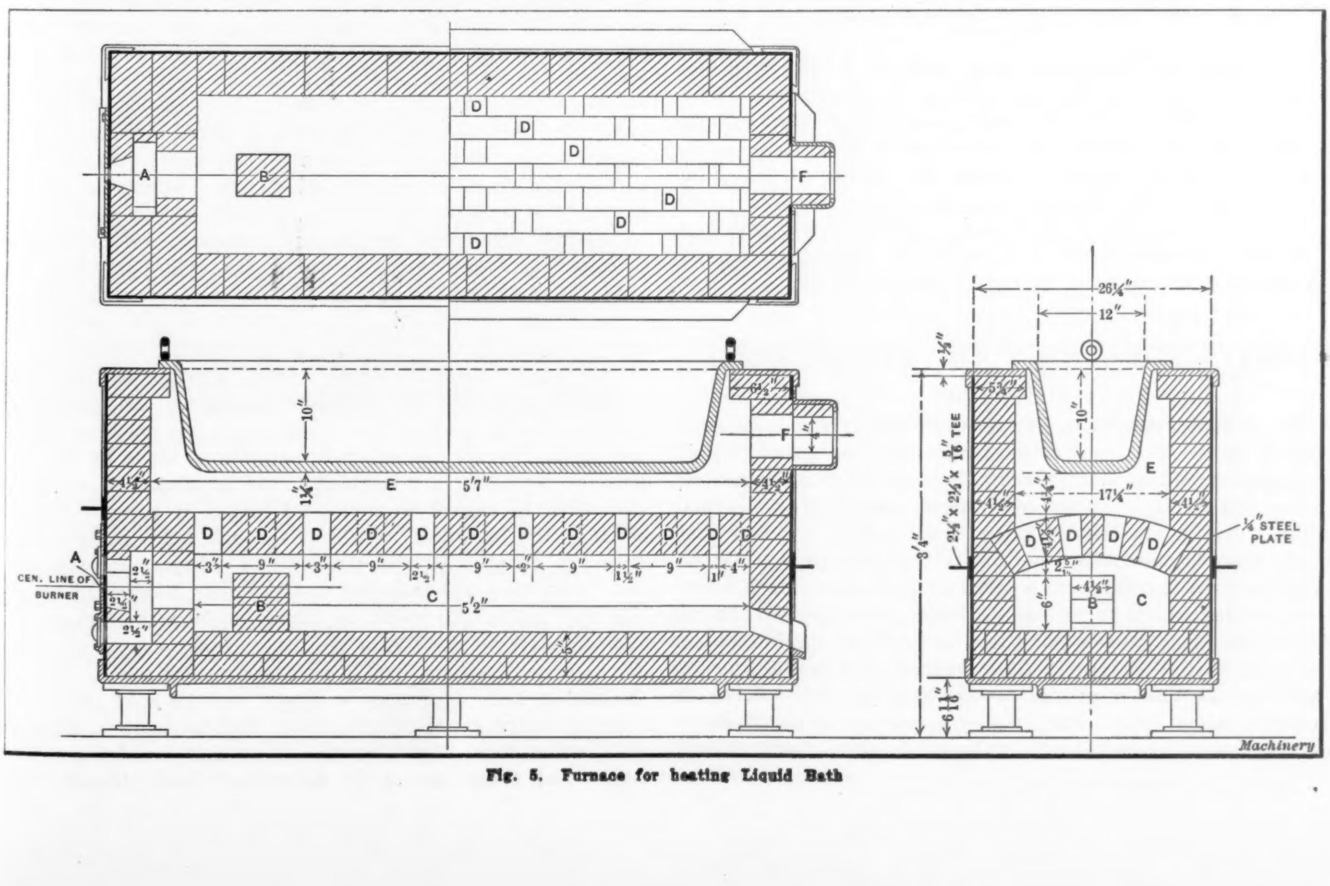

Fig. 5. Furnace for heating Liquid Bath

Furnace & Foundry Co. and uses a honeycombed arch similar to that shown in Fig. 3. The arch is used underneath a lead pot to separate the combustion chamber from the heating chamber and more evenly distribute the heat underneath the entire length of a five-foot lead pot. The flames from the burner enter opening *A* and strike the baffle plate *B* where they are broken up and distributed to both sides of combustion chamber *C*. The hot gases then pass through honeycombed openings *D* into heating chamber *E* and the spent gases leave the furnace through vent *F*. Salt hardening and tempering bath furnaces are finding more users every day,

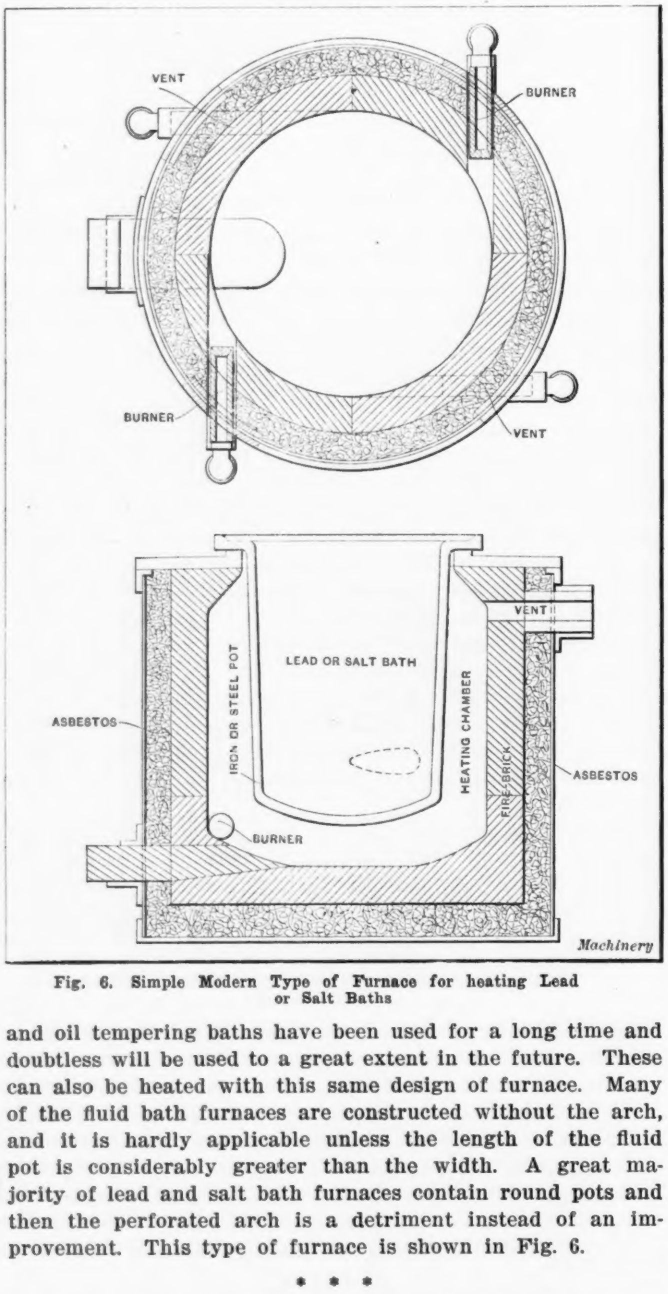

Fig. 6. Simple Modern Type of Furnace for heating Lead or Salt Baths

and oil tempering baths have been used for a long time and doubtless will be used to a great extent in the future. These can also be heated with this same design of furnace. Many of the fluid bath furnaces are constructed without the arch, and it is hardly applicable unless the length of the fluid pot is considerably greater than the width. A great majority of lead and salt bath furnaces contain round pots and then the perforated arch is a detriment instead of an improvement. This type of furnace is shown in Fig. 6.

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LIMITS FOR THE TOOL DEPARTMENT

BY C. KNOWLES*

The tool department in any shop should be put on a commercial basis, *i. e.*, rate of production as well as quality of the work should be considered. It is often said that a toolmaker always uses the slowest speed and feed on his machine. This is not true in many cases, but it is a fact that much time is wasted by working too accurately. It is impossible for a toolmaker in a large shop to know much about the part for which he is making tools; therefore, he has no knowledge of conditions on which to form an opinion of the accuracy that is required. The foreman and inspector who have a great number of jobs to look after are even worse off in this respect. Of course, these men could make inquiries and thus obtain a knowledge of the fundamental facts of each case, but this would mean additional time and expense to charge against the department. The result is that many tool departments establish a standard of their own, which is too accurate for some jobs and not accurate enough for others.

The proper time to decide on the allowable limits for each tool is at the time it is designed. In planning tools for the manufacture of a given part, the designer should thoroughly investigate the relation of this part to other members of the machine and specify the limit of accuracy accordingly. For example, if the work is a bracket with screw and dowel-pin holes and two bearings for shafts carrying gears in mesh, the following conditions will have to be met. The screw and dowel-pin holes must match the holes in the piece to which the bracket is secured. The designer knows that the stock screws used in the shop are a certain amount small, and that it is the custom to drill dowel-pin holes under size and ream them with the two parts in position. Thus he realizes that the jigs for the two parts do not have to be exactly right, but can vary from each other by the amount that the screws are smaller than the screw holes. The bearing holes for the shafts must not be too short on the center distance, as standard gears would bind under such conditions. On ordinary work, however, if the center distance is a trifle long, the resulting backlash will do no harm. The principal reason for making a jig is to provide interchangeability, and if a considerable number of the parts are to be manufactured, the cost of production will also be reduced. Accuracy is required in the jig for this purpose and it can only be made in a well equipped toolmaking department.

In many cases the jig is used because of the convenience with which it enables the work to be handled, thus reducing production costs. When interchangeability of parts is not a factor, scale measurements would be close enough and the jig could be made by an ordinary workman using manufacturing machines. In order to design tools intelligently, the designer must know all of these conditions, and his work is not complete unless he specifies the allowance limits or permissible variation from standard dimensions in each case. All locating points, studs and bushings, center distances and other dimensions, which, for any reason must be held close, should be given the widest limit that is consistent with the work that is to be produced by the tool. In all cases it should be borne in mind that the last 0.00025 inch means delay and expense. This recommendation in regard to the allowable variations from specified dimensions should be used on gages, cutting tools and all other classes of tool work.

Knowing the accuracy to which each tool must be finished, the tool-room foreman can lay out his work with the view of securing the greatest possible economy. The accurate work can be given to the men best qualified to handle it and these men can be assigned to the best machines in the tool-room. Similarly, the lower grade of work can be given to the less expert mechanics and these men can be given the use of manufacturing machines which can be forced with the view of increasing production. In many cases when the tool department is rushed, this low-grade work can be turned over to the manufacturing department with very satisfactory results. It is often necessary to duplicate a tool which was made at some previous time, and if the proper limits are recorded on the drawing, this can be done without measuring or referring to the old tool in any way.

The recommendations given in this article may be briefly summarized as follows: By having properly established and recorded limits we are able to obtain greater efficiency in the tool-room. Delays caused by investigations made by the foreman or workmen are avoided. The provision of exact information in regard to each tool makes it possible for the work of the tool-room to be put through more rapidly. The tools are adapted in both quality and accuracy for the work for which they are intended and economy is effected by giving the high-grade work to highly skilled mechanics, and less accurate work to men of more meager experience. The work is classified so that, if necessary, work which does not demand a high degree of accuracy may be sent out to the manufacturing departments. Tools may be made in duplicate or existing tools may be matched without involving the expense and delay caused by measuring tools already made.

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AUTOMATIC INDEXING FIXTURE FOR CUTTING INTERNAL RATCHET GEARS

BY ALFRED SPANGENBERG*

In considering the design of fixtures for machining small parts in quantities, the introduction of automatic features will often effect a large saving in the cost per piece by cutting down the time between cuts. This applies particularly where the operations involve frequent indexing of the work, since the elimination of hand indexing, with the consequent starting and stopping of the machine, will effect a further economy in labor by enabling the operator to run two machines, thereby securing a material reduction in the cost per piece.

This principle is well illustrated in the accompanying illustrations, which show an automatic indexing fixture for cutting small internal ratchet gears on a Brown & Sharpe No. 3 milling machine equipped with a commercial slotting attachment. The fixture is in use at the Pond Works of the Niles-Bement-Pond Co., Plainfield, N. J. The ratchet gear *A* to be machined has thirty-two internal teeth of 1-inch face width by 1/16 inch depth, while the bore of the hole is 2⅜ inches in diameter. A number of other sized gears are cut on this fixture by substituting indexing wheels *B* having the required number of teeth. As will be seen from Fig. 2, the fixture proper consists of a suitable bed-plate *C* that forms a bearing for stud *D*, to which is secured the indexing dial bearing *E*. Rigidity of the index wheel and its bearing *E* against the pressure of the cut is secured by a finished seat of ample diameter on casting *C*.

The index wheel and its members *D* and *E* are free to revolve on the bed-plate *C*, but to prevent over-travel during

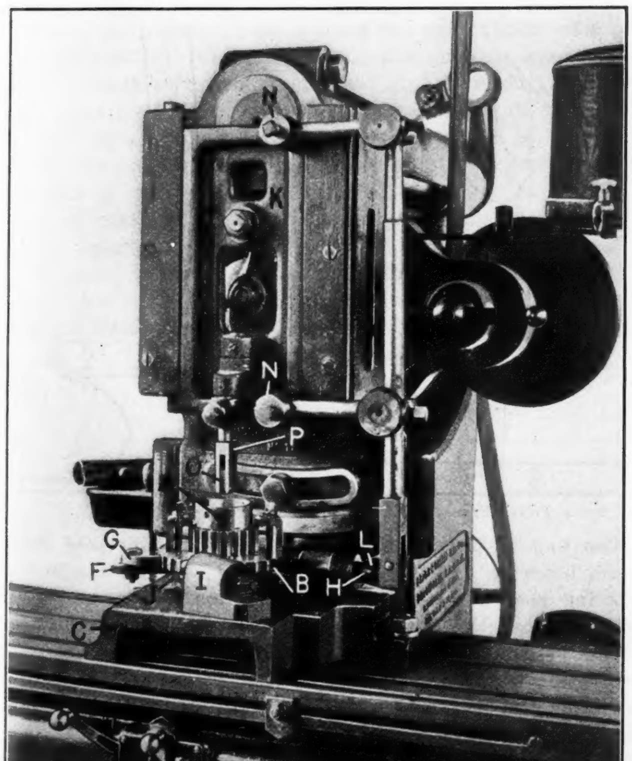

Fig. 1. Automatic Indexing Fixture in Position on Brown & Sharpe Milling Machine

the operation of indexing, a light tension is secured by means of a lock-nut and spring washer carried on the lower end of stud *D*, which imposes an additional friction between the under surface of the bearing *E* and the finished surface of the bed casting. The bearing *E* is turned on its periphery to fit the bore of the rocker *F* which carries a pawl *G* and the link connection to the spring plunger *H*. Cast integral with the bed-plate is a bearing *I* for the dial locating plunger *J* which is operated by a suitable spring contained within the bearing. Power for the automatic indexing is derived from the slotting attachment ram *K*, Fig. 1, to which the pawl *L* is attached by means of supporting rods.

In operation, the stroke of the ram is set to over-travel about one inch above the teeth in the work. This permits pawl *L*, during the over-travel on its upward stroke, to engage plunger *H*, the indexing being effected by means of the rocker *F* and its mechanism. The pawl *L* is hinged as shown, so that no indexing takes place during the downward stroke of the tool. The function of plunger *J* is to locate and hold the index dial *B* during the cutting stroke. Dotted lines at *M*, Fig. 2, show the normal position of plunger *J* against the index dial. The feeding only takes place upon the completion of each revolution of the work. The feeding of the work in to the tool is accomplished by moving the milling machine

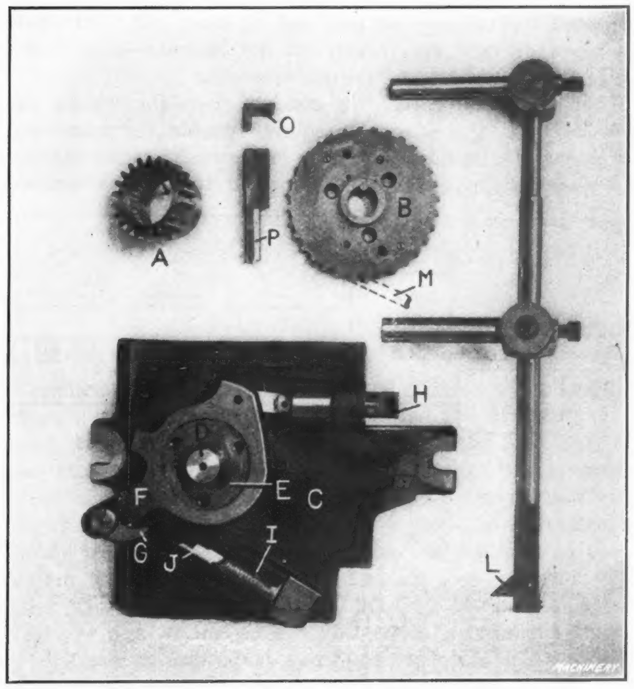

Fig. 2. Details of Fixture illustrated in Fig. 1

table crosswise by hand. At the start, the depth of cut is set at about 0.050 inch and this is gradually decreased at each revolution of the work until the final depth is reached, which requires three revolutions, because each successive cut is heavier.

As was previously stated, ratchet gears of several sizes having different numbers of teeth are cut on this fixture. Consequently, the rocker mechanism must be adjustable in its movement. This is provided for by a horizontal adjustment of the pawl-carrying arms in the studs *N*. The method of centering and clamping the work is made clear by a study of the illustrations. To provide relief for the cutter during its return stroke, the cutter *O* is made L-shaped and is hinged in its holder *P*. The tool-holder is drilled to receive a spring that presses against the heel of the cutter and so keeps it in its normal position.

Previous to the introduction of the fixture described in this article, the ratchet gears in question were cut on a regular slotting machine, using a somewhat similar fixture except that the indexing was accomplished by hand. This method produced about five finished ratchet gears per hour, while with the new method the output averages about twenty-five per hour—an increase of production of 500 per cent. The external gear teeth in these ratchet gears are, of course, previously finished in a regular gear-cutting machine.

* * *

Plans have been filed with the Bureau of Buildings, New York City, for an office building which will be 894 feet high. The structure is proposed to be built on the block bordered by Broadway, Eighth Ave., 57th and 58th Sts., and to be fifty-one stories high. The design is to follow the Gothic style. The building is to be built by the Pan-American State Association, and the tower will be surmounted by an allegorical figure representing the association. The estimated cost is $12,500,000.

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DUPLEX SAFETY TRIPPING DEVICE

BY JAMES H. RODGERS*

The cause of a great number of crippled hands of men employed in the iron or sheet-metal working trades can be traced to the power press, where the starting and stopping depends entirely upon the operator. The starting of a large majority of the different makes of power presses is by depressing the well-known form of foot treadle located below the bed of the machine, which releases the latch that holds the clutch out of gear and allows the crankshaft to make one revolution. As soon as the press is in action the foot must be lifted or removed from the treadle to allow the latch to return to its former position. In nine cases out of ten, when an accident takes place, the operator will say that the press "repeated." This may or may not be true; but if the press did repeat, it was due largely—if not entirely—to a lack of caution displayed by the person operating it.

When an operator removes his foot from the treadle each time he trips the press, it requires double the number of movements to perform his work, and where from 10,000 to 30,000 operations a day are performed it involves considerable muscular action in the operator's leg and foot. Where an operator does not remove his foot from the treadle, but allows it to return after releasing the press, he must retain considerable tension upon the muscles of his limb in order to prevent the depression of the operating treadle before the proper time. Now, one not familiar with the operation of power presses has only to imagine what effect this muscular strain would have on a person who is practically holding the weight of his leg up for from seven to ten hours a day. Another objectionable feature of the method of tripping with an ordinary treadle, and one that is deserving of censure, is the custom of a large number of press operators of allowing the treadle to rise just far enough for the latch to operate the clutch-pin. The writer has seen cases where operators allow only one-eighth inch contact when there should be one-half inch. An observer can readily see that this perilous condition of affairs neither facilitates the operation nor increases the rapidity of action. But it does make it possible for the operator, when placing work in position, to unintentionally depress his foot sufficiently to trip the press, owing to his carelessness in not allowing the latch to return to its proper position. It is this condition more than any other that causes the majority of power press accidents.

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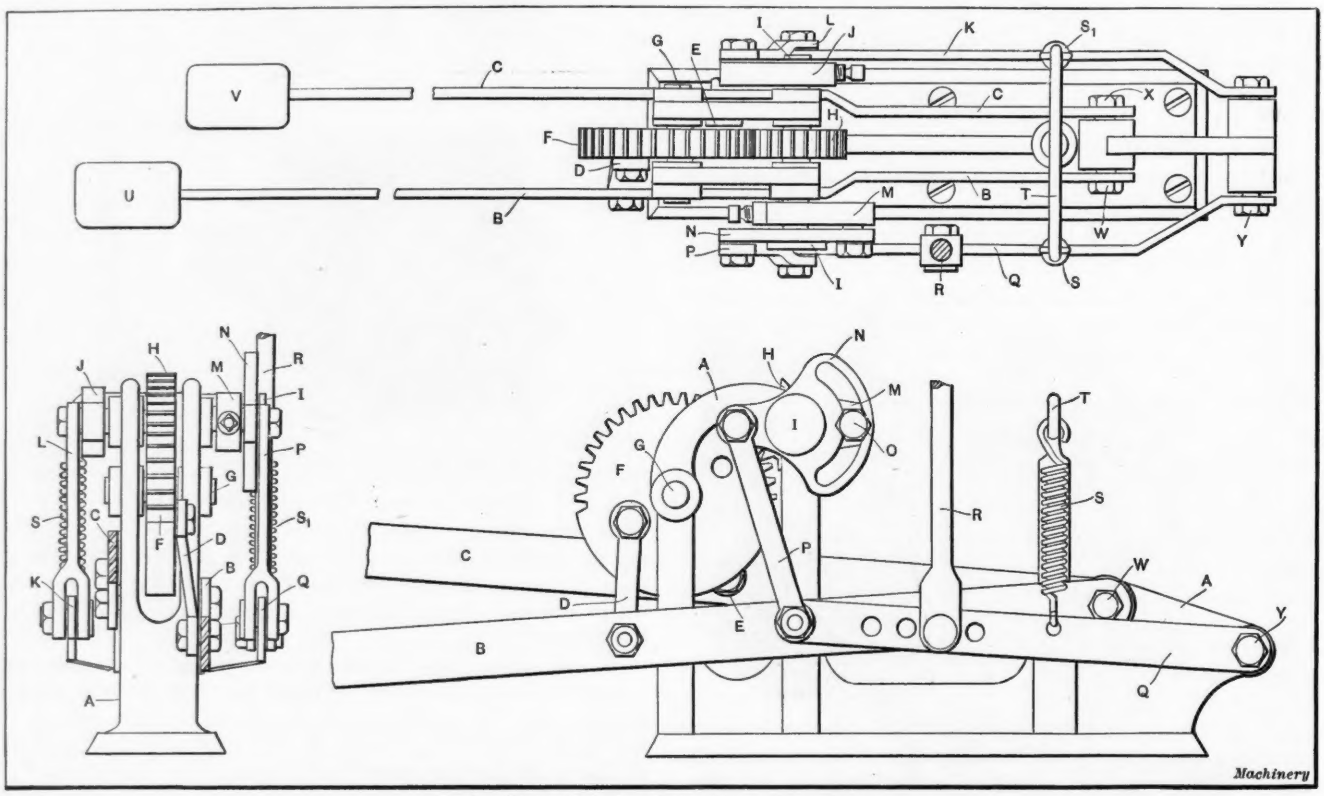
The accompanying illustration shows a duplex safety tripping device which reduces to a minimum the number of accidents traceable to the carelessness of the operator. In this illustration, *A* is the frame casting that is secured to the floor below the press. Fulcrumed at *W* and *X* are the two treadle levers *B* and *C* which extend to the front of the machine in the ordinary manner. The links *D* and *E* connect the treadles *B* and *C* with the gear *F* at diametrically opposed points. The shaft *G* on which gear *F* is mounted rotates through an angle of about 60 degrees. Meshing with gear *F* and carried by the shaft *I* is the pinion *H*, and secured to the left-hand end of shaft *I* is the crank *J* which is connected to the lever *K* by the link *L*. On the opposite end of the shaft *I*, and secured to it, is another crank *M*. Outside the crank *M* and free to rotate is the slotted disk *N*, which is held in position by the head on the shaft *I* and the stud *O*. The link *P* connects the disk *N* with the auxiliary treadle lever *Q* which is fulcrumed at *Y*. The trip-rod *R* is secured to the auxiliary treadle lever *Q* in the ordinary manner. The tee-post *T* carries the two springs *S* and S_1, which makes the action of the mechanism positive after the operator has tripped the press.



Duplex Safety Tripping Device for a Power Press

The foot is placed on the foot-rest *V* and pressed downward, lowering the treadle lever *C* and through the link *E*, rotating gear *F* in a clockwise direction. This causes the pinion *H* and the two cranks *J* and *M* to rotate in the opposite or counterclockwise direction. When the crank *M* has rotated through an angle of from 60 to 90 degrees, governed by the length of the slot in the disk *N*, the stud *O* comes into contact with the end of the slot and begins to rotate the disk *N*. Through the link *P*, auxiliary treadle lever *Q* and trip-rod *R*, the latch is released by the continued downward pressure of the operator's foot and then carried back to position to stop the press after the crankshaft has made one revolution. By lowering the other treadle *U* (which by the above action has been raised ready for the next operation) the movement of the mechanism is again performed in the opposite direction but with the same results. Every time either treadle is pushed down the press is released and automatically locked after making one revolution.

It will be seen from the illustration that the cranks *J* and *M* will have passed the center before the latch releases the clutch, and as the spring S_1 is under greater tension than the other spring *S*, the mechanism will perform the movement independent of the operator. The muscular tension on an operator's limb will, therefore, be reduced to a minimum.

STEAM POWER PLANT PIPING DETAILS*-8

THE DESIGN AND ERECTION OF EXPANSION BENDS

BY WILLIAM F. FISCHER†

IN previous numbers of MACHINERY, rules and tables were presented from which to estimate the amount of expansion and contraction to be cared for in a steam main of a given length conveying steam at a given pressure. Having determined the amount of expansion to be cared for, the designer should next decide upon the most suitable method of compensation. For low-pressure steam and exhaust mains, expansion joints of any suitable standard make may be used to take up or relieve the strains on the piping system (see MACHINERY, November, 1913), but for high-pressure steam mains, it is customary and advisable to use expansion pipe bends made up of full-weight or extra-heavy steel or wrought-iron pipe. When the steam main is of considerable length it is advisable to divide the expansion between different sections of the piping system, anchor the main rigidly at a point near the middle of each section, and provide an expansion bend in each section, as mentioned and illustrated in a previous number of MACHINERY. Having decided upon the location of the expansion bends, the next question to be determined is the type of bend to be used and its dimensions. The exact amount of expansion that can be taken care of by a wrought-iron or steel pipe bend of given dimensions is a matter of some uncertainty. Distortion of a pipe bend beyond a certain stage throws very heavy bending strains on the pipe joints and outer fibers of the material from which the bend is made. Before excessive bending strains are reached, however, expansion bends, if properly proportioned and suited to the conditions, will prove as flexible as most other methods of caring for expansion and contraction, and will be found much safer in operation. The amount of expansion that can be taken care of by an expansion bend of wrought-iron or steel pipe depends upon the shape of the bend, the mean radius of the bend, the outside diameter of the pipe from which the bend is made, and the amount of straight pipe allowed between the arcs or curved portions of the bend.

Practical data relating to the design of expansion bends is rather scarce. The writer has no excuse to offer in presenting the following approximate rules, formulas and tables relating to the design of expansion bends, other than the fact that they will be found well on the safe side for each case considered and that they are to be used as a guide in determining proportions rather than as hard and fast rules. In making up a steel or wrought iron pipe bend, it is necessary to provide a short length of straight pipe at each end where the flanges connect to the bend. It is also advisable to allow a short length of straight pipe between the arcs or curved portions of a bend, especially where the curve is reversed in direction as at S in Figs. 65 and 66. These short lengths of straight pipe will be found to increase the flexibility of the bend, but as it would greatly complicate the formulas, rules and tables, if taken into account, the writer has ignored its effect altogether and only considered the curved portions of the bend in each case. In preparing the formulas and tables for U-shaped expansion bends, the writer used the following rules and formulas for figuring the deflection of circular rings when acted upon by two equal and opposite forces.* Fig. 61 indicates a circular ring of mean radius R acted upon by two equal and opposite forces P. The dotted lines show the form the ring assumes under stress, D and D_1 being the mean vertical and horizontal diameters of the ring before the forces P are applied, and d and d_1 the mean vertical and horizontal diameters after the forces are applied. If we consider the ring to be cut at b and divide P into two equal parts, as indicated in Fig. 62, all motions may be considered to take place about the point a. In this case, the dotted lines show the form each half of the ring will assume under the action of the forces P and $\frac{P}{2}$, D being the original mean diameter of the ring and δ the deflection of the ring when cut and loaded as shown.

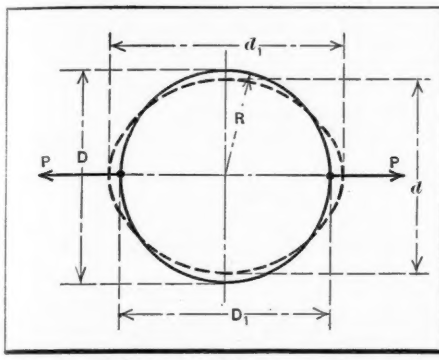


Fig. 61. Deflection in Ring due to Forces P

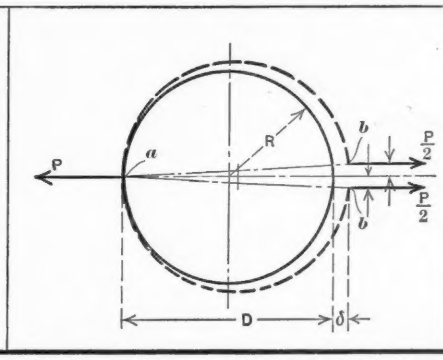


Fig. 62. Diagram used in deriving Formulas

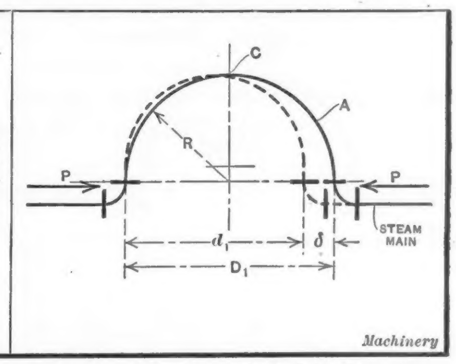


Fig. 63. U-pipe Bend strained by Expansion

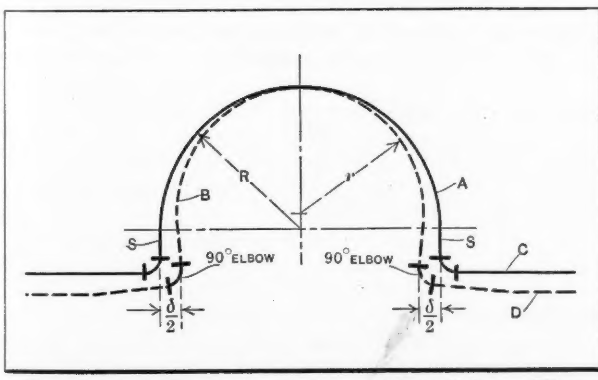


Fig. 64. Single U-expansion Bend connected to 90-degree Elbows

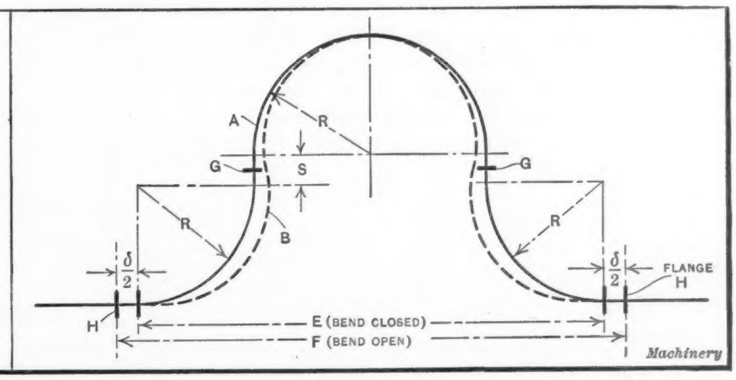


Fig. 65. Expansion Bend that reduces Bending Stress in Main

Let δ = horizontal deflection of ring in inches;
P = concentrated load, in pounds, acting upon ring;
R = mean radius of ring in inches;
E = modulus of elasticity of the material in ring;
I = moment of inertia of a cross-section of ring;
$\pi = 3.1416$.

* The seventh installment of "Steam Power Plant Piping Details" was published in the November number of MACHINERY.

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* See "Deflections and Statically Indeterminate Stresses," by Clarence W. Hudson.

Then, according to Professor Hudson:

$$\delta = \frac{P\pi R^3}{4EI} \qquad (11)$$

$$M_b = \frac{PR}{\pi} \qquad (12)$$

where M_b = maximum bending moment on ring, in inch-pounds, due to concentrated load P.

In any segment of the ring, the external forces acting on the ring will be held in equilibrium by the internal, or resisting forces acting upon the segment at its two ends. Therefore, in order that the ring may be of sufficient strength, the resisting moment, M_r, in inch-pounds, due to the internal stresses at any section of the ring, should equal the bending moment, M_b, in inch-pounds at that section, due to the external forces. Therefore:

$$M_b = M_r \qquad (13)$$

where M_b = maximum bending moment in inch-pounds;
M_r = corresponding resisting moment in inch-pounds.

From Formula (12) we find that $M_b = \frac{PR}{\pi}$. We also know that the resisting moment for a beam of any cross-section is:

$$M_r = \frac{fI}{y}. \qquad (14)$$

where f = allowable fiber stress in pounds per square inch;
I = moment of inertia of a cross-section of the beam;
y = distance, in inches, from the neutral axis of beam to outermost fibers.

Therefore, if we substitute the above values in Formula (13) we have:

$$M_b = M_r \text{ or } \frac{PR}{\pi} = \frac{fI}{y}. \qquad (15)$$

By transposing in (15) we get:

$$P = \frac{fI\pi}{Ry}. \qquad (16)$$

Now if we substitute $\frac{fI\pi}{Ry}$ for P in Formula (11), we have:

$$\delta = P \times \frac{\pi R^3}{4EI} = \frac{fI\pi}{Ry} \times \frac{\pi R^3}{4EI}$$

$$\delta = \frac{f\pi^2 R^2}{4Ey}. \qquad (17)$$

This formula gives the deflection δ of the ring in terms of the fiber stress f. See Figs. 61 and 62.

Formulas for Deflection of U-shaped Expansion Bends

In applying the above formulas to expansion bends, the writer assumes the conditions shown in Fig. 63, *i. e.*, a U-shaped expansion bend A, of radius R, acted upon by two equal and opposite forces P. These forces act in the direction of the arrows when the bend is caring for expansion in a steam main, and in the opposite direction when the bend is caring for contraction in a main. It should be noted that the expansion bend A is acted upon by two equal and opposite forces P, while each half of the split ring in Fig. 62 is loaded only one-half as much, being acted upon by two equal and opposite forces $\frac{P}{2}$. Therefore, in order to apply Formula (11) to expansion bends as shown in Fig. 63, the writer has multiplied the formula as it stands, by 2, as follows:

$$\delta = 2 \times \frac{P\pi R^3}{4EI} = \frac{P\pi R^3}{2EI}. \qquad (18)$$

Formula (18) is not yet in the desired form for expansion bends, however, for the following reasons: In the case under consideration, the equal and opposite forces P cause the bend to deflect an amount δ. In the case of an expansion bend serving a steam main, however, the force P is unknown and would have to be determined before applying Formula (18). For example, when the steam main (Fig. 63) expands, it lengthens an amount δ, thereby causing the expansion bend A to deflect and close up an equal amount, as shown by the dotted lines. As the force of expansion is practically irresistible, we know that the bend must give sufficiently to take up the expansion in that particular section of the piping system served by the bend. Therefore it is not necessary to compute the magnitude of the thrust P due to expansion of the steam main, but rather to compute the unit fiber stress f in pounds per square inch in the outer fibers of the material of the bend, due to the bend deflecting an amount δ. From Formula (17) we found $\delta = \frac{f\pi^2R^2}{4Ey}$, which is the deflection of a ring in terms of the unit fiber stress f. Therefore, if we multiply by 2, we get for the deflection of an expansion bend in terms of the unit fiber stress f:

$$\delta = 2 \times \frac{f\pi^2R^2}{4Ey} = \frac{f\pi^2R^2}{2Ey}. \qquad (19)$$

Substituting 9.87 for π^2 and transposing gives:

$$\delta = \frac{\pi^2 fR^2}{2Ey} = \frac{9.87fR^2}{2Ey} = 5 \times \frac{fR^2}{Ey} \qquad (20)$$

$$f = \frac{Ey\delta}{5R^2} \qquad (21)$$

$$R = \sqrt{\frac{\delta Ey}{5f}}. \qquad (22)$$

Formulas (20), (21) and (22) are in the final form desired for U-shaped expansion bends—as shown in Figs. 63 and 64. For mild steel and wrought-iron pipe, the modulus of elasticity E may be taken as 29,000,000, in which case Formula (20) may be further simplified as follows:

For an allowable unit fiber stress f = 12,000 pounds per square inch:

$$\delta = \frac{5 \times 12{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.0021\,\frac{R^2}{y} \qquad (23)$$

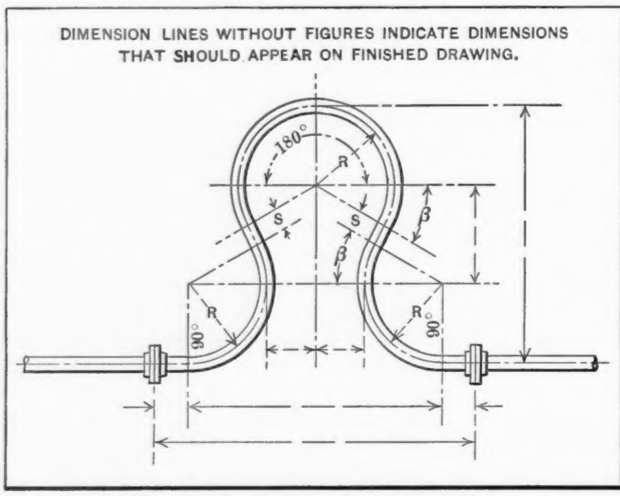


Fig. 66. Double Offset Expansion Bend

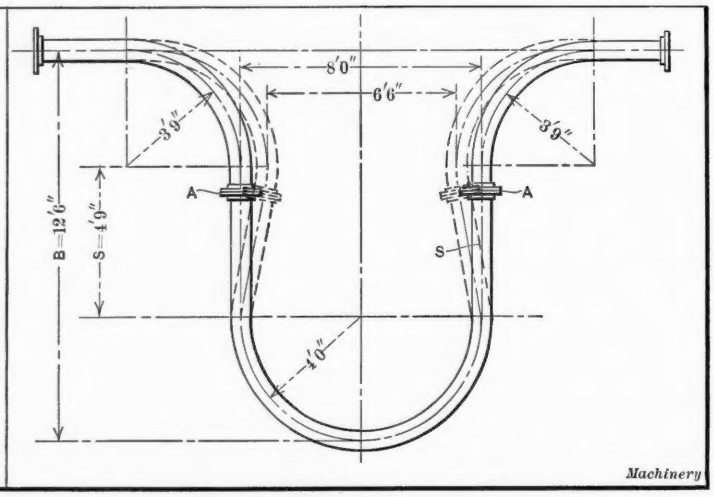


Fig. 67. Kellogg Improved Expansion Bend

For an allowable unit fiber stress $f = 15{,}000$ pounds per square inch

$$\delta = \frac{5 \times 15{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.0026\,\frac{R^2}{y}. \qquad (24)$$

For an allowable unit fiber stress $f = 18{,}000$ pounds per square inch

$$\delta = \frac{5 \times 18{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.0031\,\frac{R^2}{y} \qquad (25)$$

and for an allowable unit fiber stress $f = 20{,}000$ pounds per square inch

$$\delta = \frac{5 \times 20{,}000}{29{,}000{,}000} \times \frac{R^2}{y} = 0.00345\,\frac{R^2}{y}. \qquad (26)$$

Formulas (23) to (26), inclusive, were used by the writer in estimating the values of δ in Tables X to XIII inclusive. Formulas (20) to (26), inclusive, may be applied to U-shaped expansion bends as illustrated in Figs. 63 and 64, where the short lengths of straight pipe at each end of the bend are not considered. Values of y, for the different standard sized pipes will be found in the fifth column of Table IX, and in the sixth column of this table will be found values of the moment of inertia I, to be used in connection with Formula (18) in cases where the concentrated load P is known. To illustrate the use of Formulas (20), (21) and (22), and Tables IX to XIII the following examples are given:

Example 1:—The expansion δ of a 6-inch steam main is found by calculation to be 1.44 inch and it is desired to care for this expansion by installing a 6-inch U-bend as illustrated in Fig. 63. To what radius should the bend be curved in order that the extreme fiber stress f on the material of the bend will not exceed 12,000 pounds per square inch? By Formula (22) we find that the value of the radius is:

$$R = \sqrt{\frac{\delta E y}{5f}}. \qquad (22)$$

From the above:

$\delta = 1.44$ inch;

$E = 29{,}000{,}000$;

$f = 12{,}000$ pounds per square inch;

$y = 3.3125$ (see Table IX).

Substituting these values in Formula (22) gives:

$$R = \sqrt{\frac{1.44 \times 29{,}000{,}000 \times 3.3125}{5 \times 12{,}000}} = \sqrt{2305.5} = 48 \text{ inches}$$

This will be found to check with Table X. Under 6-inch pipe and opposite 48-inch radius will be found $\delta = 1.44$, the expansion cared for by a 6-inch U-bend at a fiber stress of 12,000 pounds per square inch.

Example 2:—It is desired to estimate the unit fiber stress f on the material of the 6-inch U-bend if curved to a radius of 42 inches instead of 48 inches, all other conditions being the same as in Example 1. By Formula (21), we find that

$f = \dfrac{Ey\delta}{5R^2}$ and with $R = 42$ inches:

$$f = \frac{29{,}000{,}000 \times 3.3125 \times 1.44}{5 \times 42 \times 42} = \frac{138{,}330{,}000}{8820} = 15{,}680 \text{ pounds}$$

per square inch.

As a check on this result consult Table XI. Under 6-inch pipe and opposite 42-inch radius will be found 1.39 inch, the expansion cared for by a 6-inch U-bend of 42-inch radius, at a fiber stress of 15,000 pounds per square inch. The same bend when caring for 1.44 inch expansion is subjected to a fiber stress of 15,680 pounds per square inch, as per Example 2.

Example 3:—As an example showing the use of the tables assume the following conditions: The expansion of an 8-inch steam main is found by calculation to be 1.65 inch $= \delta$. To what radius should an 8-inch U-bend be curved in order to care for this expansion without stressing the material of the bend beyond 12,000 pounds per square inch? Table X gives the expansion cared for by U-bends of different sizes of pipe bent to various radii. Under the column headed 8-inch pipe, 1.65 is found to lie between 1.40 with a corresponding radius of 54 inches, and 1.73 with a corresponding radius of 60 inches. To determine the radius required to care for 1.65 inch expansion, proceed as follows:

Let e = expansion to be cared for = 1.65 inch;

X = radius required for this expansion;

δ = next lowest known deflection (from table);

R = radius corresponding to known deflection (from table).

Then, as the deflection of a U-bend (or the expansion cared for) varies as the square of the radius —see Formula (20)— we have:

$$X^2 = \frac{R^2 \times e}{\delta} \text{ or } X = \sqrt{\frac{R^2 \times e}{\delta}}$$

The expansion e to be cared for = 1.65 inch and the next lowest known deflection from table = 1.40 inch, with the corresponding radius $R = 54$ inches. The required radius X is then found to be:

$$X = \sqrt{\frac{54^2 \times 1.65}{1.40}} = \sqrt{\frac{4811.4}{1.40}} = \sqrt{3437} = 58.63 \text{ inches—say 59}$$

inches. These results may be checked by Formula (22)

$$R = \sqrt{\frac{\delta E y}{5f}} \qquad (22)$$

where $E = 29{,}000{,}000$;

$f = 12{,}000$ pounds per square inch;

$\delta = 1.65$ inch;

y = for an 8-inch pipe 4.3125. (See Table IX.)

Substituting these values in Formula (22) gives:

$$R = \sqrt{\frac{1.65 \times 29{,}000{,}000 \times 4.3125}{5 \times 12{,}000}} = \sqrt{3439} = 59 \text{ inches approximately.}$$

When designing expansion bends, it is not advisable to allow much over 15,000 pounds per square inch for the fiber stress f on the material of the bend, as the material has already been strained to some extent in heating and curving the bend to the required form. Fig. 64 illustrates the action of a single U-shaped expansion bend as used in connection with two 90-degree elbows for taking care of expansion and contraction in a steam main. The full lines A and C show the position of the bend and part of the steam main before steam is turned into the piping system, and the dotted lines B show the approximate position of the bend when caring for expansion after steam is turned into the piping system. As the 90-degree, cast-iron elbows at each end of the bend make a very rigid connection at this point, a more or less severe bending strain is thrown on the steam main at D as the bend deflects in caring for the expansion of the main. Increasing the length of straight pipe at each end of the bend, as at S in Fig. 64, tends to increase the strain at this point to some extent because the bending moment increases with any increase of length S. For this reason it is advis-

TABLE IX. PROPERTIES OF STANDARD WEIGHT STEEL AND WROUGHT IRON PIPE*

1	2	3	4	5	6	7	8
Standard Pipe Size	Inside Diameter d Inches	Outside Diameter D Inches	Thickness of Metal t Inches	Distance from Neutral Axis to Outermost Fiber, in Inches $y = \frac{D}{2}$	Moment of Inertia I	Section Modulus $Z = \frac{I}{y}$	Area of Metal in Square Inches
1	1.049	1.315	0.133	0.6575	0.08734	0.1328	0.4936
$1\frac{1}{4}$	1.380	1.660	0.140	0.830	0.1947	0.2346	0.6685
$1\frac{1}{2}$	1.610	1.900	0.145	0.950	0.3099	0.3262	0.7995
2	2.067	2.375	0.154	1.1875	0.6657	0.5606	1.075
$2\frac{1}{2}$	2.469	2.875	0.203	1.4375	1.530	1.064	1.704
3	3.068	3.500	0.216	1.750	3.017	1.724	2.228
$3\frac{1}{2}$	3.548	4.00	0.226	2.000	4.788	2.394	2.680
4	4.026	4.50	0.237	2.250	7.233	3.214	3.174
$4\frac{1}{2}$	4.506	5.00	0.247	2.500	10.440	4.177	3.688
5	5.047	5.563	0.258	2.7815	15.160	5.451	4.300
6	6.065	6.625	0.280	3.3125	28.140	8.496	5.581
8	8.071	8.625	0.277	4.3125	68.350	14.690	7.265
10	10.192	10.750	0.279	5.375	125.90	23.420	9.178
12	12.090	12.750	0.330	6.375	248.50	38.970	12.880
14	14.250	15.000	0.375	7.500	461.00	61.460	17.230
15	15.250	16.000	0.375	8.000	562.10	70.260	18.410

Machinery

* Condensed from National Tube Co.'s Handbook—1913 Edition

TABLE X. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress = 12,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches													
	1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D.	16 O. D.
	Expansion cared for by U-bend = (δ) in Inches													
12	0.465	0.25	0.21	0.18	......	......	......	......	......	......	......	......	......	......
18	1.300	0.57	0.47	0.38	0.34	0.30	0.27	0.24	0.22	......	......	......	......	......
24	1.830	1.00	0.83	0.68	0.60	0.53	0.48	0.43	0.36	0.28	......	......	......	......
30	2.840	1.57	1.30	1.07	0.94	0.83	0.75	0.67	0.56	0.43	0.35	......	....	......
36	4.075	2.26	1.86	1.53	1.34	1.20	1.07	0.97	0.81	0.62	0.50	0.42	......	......
42	5.553	3.06	2.54	2.08	1.83	1.63	1.46	1.31	1.10	0.85	0.68	0.57	0.49	......
48	.....	4.00	3.31	2.72	2.38	2.12	1.91	1.72	1.44	1.11	0.89	0.75	0.64	0.60
54	.....	5.08	4.20	3.45	3.00	2.68	2.41	2.17	1.83	1.40	1.22	0.95	0.81	0.76
60	......	6.25	5.18	4.25	3.72	3.30	2.98	2.68	2.25	1.73	1.39	1.17	1.00	0.93
66	......	7.58	6.25	5.16	4.50	4.00	3.61	3.23	2.73	2.09	1.68	1.42	1.21	1.13
72	......	9.05	7.48	6.15	5.38	4.78	4.30	3.87	3.26	2.50	2.00	1.69	1.44	1.35
78	......	10 60	8.75	7.20	6.30	5.60	5.05	4.53	3.81	2.92	2.34	1.98	1.68	1.58
84	......	......	10.02	8.35	7.32	6.50	5.85	5.27	4.42	3.40	2.72	2.30	1.95	1.83
90	......	......	......	9.60	8.40	7.45	6.70	6.00	5.07	3.90	3.13	2.63	2.25	2.10
96	......	......	......	......	9.56	8.50	7.65	6.88	5.78	4.43	3.55	3.00	2.55	2.39
102	......	......	......	......	......	9.75	8.62	7.75	6.50	5.00	4.00	3.38	2.87	2.70
108	......	......	......	......	......	......	9.66	8.70	7.30	5.60	4.50	3.80	3.22	3.02
114	......	....	......	......	......	......	......	9.68	8.15	6.25	5.00	4.22	3 59	3.36
120	....	......	......	......	......	......	......	......	9.00	6.92	5.55	4.68	4.00	3.73

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

able to increase the radius of the bend rather than to increase the length of straight pipe at each end of the bend to obtain the same results.

The use of expansion bends of the form shown in Figs. 65 and 66 does away with the bending action on the steam main as the strain at this point (D, Fig. 64) is then taken care of by the reverse curve of the bend, as indicated in Fig. 65 by the dotted lines. In the latter illustration, the full lines A show the position of the bend when the steam main is cold and dotted lines B show the position of the bend when caring for expansion, in which case the bend is caused to deflect or close up an amount $\delta = F - E$, where dimension F is the original length of the bend, and dimension E is the length of the bend when caring for expansion. Very large bends of this form may be made in one piece if so desired (omitting flanges G) by welding two or more pieces of pipe together. This is now being done successfully by several of the large manufacturers of piping materials. The bend shown in Fig. 65 is made of three pieces of pipe as indicated, with flanges at the points G. In order to prevent the pipe from buckling and to insure a more perfect bend, it is always advisable to allow a short length of pipe between reverse curves, as shown at S. Expansion bends of this form will take care of at least twice as much expansion as the single U-bend shown in Figs. 63 and 64, as the bending action is distributed over twice the length of curved pipe. Therefore, in estimating the amount of expansion cared for by a bend of this type, the values for δ, as given in Tables X to XIII, inclusive, should be multiplied by 2.

Formulas for Expansion cared for by Bends of the Type shown in Fig. 65

In order to apply Formula (20) to expansion bends of the type shown in Fig. 65, it is necessary to multiply by 2, in which case we have:

$$\delta_1 = 2 \times \frac{5fR^2}{Ey} = 10 \times \frac{fR^2}{Ey}. \qquad (26)$$

Transposing in Formula (26):

$$f = \frac{Ey\delta_1}{10R^2} \qquad (27)$$

$$R = \sqrt{\frac{\delta_1 Ey}{10f}} \qquad (28)$$

where δ_1 = expansion in inches, cared for by bends;
f = allowable unit fiber stress in pounds per square inch;
R = mean radius of bend in inches;
E = modulus of elasticity of material;
y = outside diameter of pipe ÷ 2 (see Table IX).

In the preceding formula the length of straight pipe at S is not considered.

Expansion cared for by Bends of the Type shown in Fig. 66

Fig. 66 shows a "double offset expansion bend." When considerable expansion is to be cared for this is the best form of bend to use. Where the angle β is not made less than 22½ degrees, bends of this type will care for at least 2½ times as much expansion as the single U-bend illustrated in Figs. 63 and 64, as in this case the bending action is distributed over 2½ times the length of curved pipe. Therefore, in estimating the amount of expansion cared for by bends of this type, the values of δ given in Tables X to XIII, inclusive, should be multiplied by 2.5. In making up bends of this type, it is always advisable to allow a short length of straight pipe (at least equivalent to the outside diameter of the pipe from which the bend is made) between reverse curves, as shown at S. It should be understood that any increase in the length of straight pipe at S (Figs. 65 and 66) will add to the flexibility of the bend. In order to apply Formula (20) to ex-

TABLE XI. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress = 15,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches													
	1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D.	15 O. D.
	Expansion cared for by U-bend, in Inches													
12	0.58	0.32	0.26	0.22	......	......	......	......	......	......	......	......	......	......
18	1.28	0.71	0.59	0.48	0.42	0.38	0.34	0.31	0.26	......	......	......	....	......
24	2.28	1.26	1.04	0.86	0.75	0.67	0.60	0.54	0.46	0.35	......	......	......	......
30	3.56	1.97	1.63	1.34	1.17	1.04	0.94	0.84	0.71	0.54	0.44	......	......	......
36	5.13	2.83	2.34	1.93	1.69	1.50	1.35	1.21	1.02	0.78	0.63	0.53	......	......
42	7.00	3.86	3.18	2.62	2.30	2.04	1.84	1.65	1.39	1.07	0.85	0.72	0.61	......
48	......	5.03	4.16	3.42	3.00	2.66	2.40	2.17	1.81	1.39	1.12	0.94	0.80	0.75
54	......	6.37	5.25	4.33	3.79	3.37	3.03	2.73	2.29	1.76	1.41	1.19	1.01	0.95
60	......	7.35	6.50	5.35	4.68	4.15	3.74	3.36	2.83	2.17	1.74	1.47	1.25	1.17
66	......	9.53	7.88	6.49	5.68	5.04	4.58	4.08	3.43	2.63	2.11	1.78	1.52	1.42
72	......	11.35	9.40	7.73	6.75	6.00	5.40	4.86	4.08	3.14	2.50	2.14	1.80	1.69
78	......	13.30	11.00	9.05	7.93	7.05	6.35	5.70	4.80	3.68	2.95	2.50	2.12	1.98
84	......	......	12.75	10.05	9.20	8.18	7.35	6.62	5.56	4.25	3.42	2.89	2.45	2.30
90	......	......	......	12.00	10.55	9.40	8.45	7.60	6.38	4.90	3.93	3.31	2.82	2.64
96	......	......	......	......	12.00	10.65	9.60	8.65	7.25	5.58	4.48	3.78	3.20	3.00
102	......	......	......	......	......	12.00	10.80	9.72	8.15	6.27	5.03	4.24	3:60	3 38
108	......	......	......	......	......	......	12.15	10.90	9.18	7.05	5.65	4.76	4.05	3.80
114	......	......	......	......	......	......	......	12.15	10.02	7.85	6.30	5.30	4.50	4.23
120	......	......	......	......	......	......	......	......	11.35	8.70	7.00	5.88	5.00	4.70

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

pansion bends of the type shown in Fig. 66, we must multiply by 2.5, in which case we have:

$$\delta_2 = 2.5 \times \frac{5fR^2}{Ey} = 12.5 \times \frac{fR^2}{Ey}. \quad (29)$$

Transposing in Formula (29) we get:

$$f = \frac{Ey\delta_2}{12.5 \times R^2} \quad (30)$$

$$R = \sqrt{\frac{\delta_2 Ey}{12.5f}} \quad (31)$$

where δ_2 = expansion in inches cared for by expansion bends of the type shown in Fig. 66; f, R, E and y are the same as in the previous case.

In the preceding formula, the length of straight pipe at S (Fig. 66) is not considered, and it is further assumed that angle β is not made less than 22½ degrees when making up the bend in the pipe shop.

TABLE XIII. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress = 20,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches													
	1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D.	15 O. D.
	Expansion cared for by U-bend, in Inches													
12	0.77	0.42	0.35	0.29	......	......	......	......	......	......	......	......	......	......
18	1.73	0.96	0.76	0.65	0.57	0.51	0.46	0.41	0.34	......	......	......	......	......
24	3.07	1.70	1.40	1.16	1.01	0.90	0.81	0.73	0.61	0.47	......	......	......	......
30	4.80	2.65	2.19	1.80	1.58	1.40	1.26	1.13	0.96	0.73	0.59	....	......	......
36	6.90	3.81	3.15	2.60	2.27	2.02	1.82	1.64	1.37	1.05	0.85	0.71	......	......
42	9.42	5.20	4.30	3.53	3.09	2.74	2.47	2.22	1.87	1.43	1.15	0.97	0.83	......
48	......	6.78	5.60	4.60	4.03	3.58	3.22	2.90	2.44	1.87	1.50	1.27	1.08	1.00
54	......	8.65	7.13	5.86	5.14	4.57	4.10	3.70	3.10	2.38	1.91	1.61	1.37	1.29
60	......	10.60	8.75	7.20	6.30	5.60	5.05	4.53	3.81	2.93	2.34	1.98	1.68	1.58
66	......	12.80	10.06	8.73	7.63	6.78	6.10	5.50	4.60	3.54	2.84	2.40	2.04	1.91
72	......	15.25	12.60	10.04	9.10	8.08	7.27	6.53	5.50	4.23	3.38	2.85	2.42	2.27
78	......	17.90	14.80	12.20	10.65	9.50	8.50	7.68	6.45	4.95	3.97	3.34	2.84	2.67
84	......	......	17.15	14.10	12.35	11.00	9.88	8.88	7.47	5.74	4.60	3.88	3.30	3.09
90	......	......	......	16.40	14.35	12.75	11.48	10.30	8.70	6.65	5.35	4.50	3.83	3.60
96	......	......	......	......	16.15	14.35	12.90	11.60	9.75	7.50	6.00	5.07	4.30	4.03
102	......	......	......	......	......	16.20	14.60	13.10	11.00	8.56	6.80	5.72	4.87	4.56
108	......	......	......	......	......	......	16.35	14.70	12.35	9.50	7.60	6.40	5.45	5.10
114	......	......	......	......	......	......	......	16.40	13.75	10.55	8.50	7.15	6.08	5.70
120	......	......	......	......	......	......	......	......	15.25	11.70	9.40	7.90	6.73	6.30

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

Expansion cared for by a Six-inch Bend in Actual Service

A study of Fig. 67 will give the reader some idea of the amount of expansion that can be taken care of by a flexible pipe bend when properly made and installed. This expansion bend was made up of two right-angle or square bends, curved to a mean radius of 45 inches; and one U-bend curved to a mean radius of 48 inches, that is approximately eight times the diameter of the pipe from which the bend was made. A length of straight pipe, 4 feet 9 inches long, was allowed between the curved portions of the bend, as shown at S, making the center-to-center dimension of the bend 12 feet 6 inches, as shown at B. These expansion bends were made by the M. W. Kellogg Co., of Jersey City, N. J., and installed in a steam main in the yards of the Delaware, Lackawanna & Western R. R. at Hoboken, N. J. The bend was carefully measured after erection, when cold, and again after steam at 150 pounds gage pressure was turned into the 6-inch main. The full lines show the position and dimensions of the bend taken after erection, and the dotted lines show the position of the bend when caring for the expansion. The expansion of the 6-inch steam main caused the bend to close up, or deflect about 18 inches, without causing leakage at any of the pipe joints or without unduly straining the connections. Although the flanged joints A received most of the strain, due to the severe bending action at these points, the joints, upon careful inspection, showed no signs of weakness or failure. The steam main in which this bend was installed was equipped throughout with what is known as the "Kellogg improved Van Stone joint" with rolled steel flanges. When designing the bend, the long length of straight pipe was allowed at S (Fig. 67) in order to make the bend more flexible. On a bend of this type any increase in the length S adds greatly to the flexibility of the bend when caring for expansion or contraction. As far as the writer knows, no attempt was made to ascertain the unit fiber stress f due to the contraction of the bend, but from all indications the bend was not unduly strained at any time. As this bend has been in use for a number of years without giving trouble of any kind, it may be safely used as a guide in determining the dimensions and proportions of expansion bends for similar service. Expansion bends should never be curved to a radius of less than six times the diameter of the pipe from which the bend is made, and when greater flexibility is desired the radius of the bend should be increased as much as the conditions will allow.

TABLE XII. EXPANSION CARED FOR BY U-BENDS OF WROUGHT IRON OR STEEL PIPE*

Fiber Stress = 18,000 Pounds per Square Inch

Mean Radius of Bend in Inches	Size of Pipe in Inches													
	1	2	2½	3	3½	4	4½	5	6	8	10	12	14 O. D.	15 O. D.
	Expansion cared for by U-bend, in Inches													
12	0.68	0.38	0.31	0.26	......	......	......	......	......	......	......	......	......	......
18	1.52	0.84	0.70	0.57	0.50	0.45	0.40	0.36	0.30	......	......	......	......	......
24	2.73	1.50	1.24	1.02	0.90	0.79	0.72	0.64	0.54	0.42	......	......	......	......
30	4.26	2.34	1.94	1.60	1.40	1.24	1.17	1.00	0 85	0.65	0.52	......	......	......
36	6.09	3.38	2.80	2.30	2.01	1.79	1.61	1.45	1.21	0.94	0.75	0.63	......	......
42	8.35	4.60	3.80	3.12	2.74	2.43	2.19	1.97	1.65	1.27	1.02	0.86	0.73	......
48	......	6.00	4.96	4.08	3.57	3.17	2.86	2.57	2.16	1.66	1.33	1.12	0.95	0.89
54	......	7.60	6.28	5.17	4.50	4.00	3.61	3.25	2.73	2.10	1.68	1.42	1.21	1.13
60	......	9.40	7.75	6.38	5.58	4.97	4.47	4.00	3.37	2.59	2.08	1.75	1.49	1.40
66	......	11.35	9.38	7.73	6.75	6.00	5.40	4.86	4.08	3.14	2.50	2.12	1.80	1.69
72	......	13.50	11.25	9.20	8.05	7.16	6.45	5.80	4.87	3.75	3.00	2.65	2.15	2.01
78	......	15.85	13.10	10.80	9.45	8.40	7.55	6.80	5.70	4.38	3.50	2.96	2.50	2.36
84	......	......	15.20	12.50	10.10	9.75	8.68	7.90	6.63	5.08	4.08	3.42	2.92	2.74
90	......	......	......	14.35	12.55	11.15	10.00	9.00	7.60	5.83	4.68	3.94	3.35	3.14
96	......	......	......	......	14.30	12.70	11.42	10.30	8.65	6.65	5.33	4.50	3.82	3.58
102	......	......	......	......	......	14.35	12.95	11.60	9.78	7.50	6.00	5.08	4.32	4.03
108	......	......	......	......	......	......	14.50	13.00	10.95	8.40	6.75	5.68	4.83	4.53
114	......	......	......	......	......	......	......	14.50	12.20	9.35	7.50	6.33	5.34	5.05
120	......	......	......	......	......	......	......	......	13.50	10.35	8.32	7.00	6.00	5.60

Machinery

* This table applies to U-bends as shown in Figs. 63 and 64. For 90-degree bends of same radius, divide above values by 2. For bends of the form shown in Fig. 65, multiply above values by 2. For bends of the form shown in Fig. 66, multiply above values by 2½.

Erecting Expansion Bends

If one-half the calculated amount of expansion in a steam main is allowed for when cutting the pipe to length, as mentioned in a preceding installment of this article, the steam fitter, when erecting the piping system, should stretch or spring the expansion bends sufficiently to make up the connections in the main without the use of filler pieces, or "Dutch-

men," as they are called. After steam is turned into the main, the expansion removes the cold strain put on the bend by the steam fitter and in this way the bend is strained only half as much as it would be if no allowance were made in the length of the main when cutting the pipes. In all cases where one-half the expansion is allowed for in the length of the main, the expansion bends shown in the illustrations Figs. 63 to 66, inclusive, will care for twice as much expansion as calculated by aid of the formulas and tables presented in this article, or what amounts to the same thing, an expansion bend should be designed to take care of only half the calculated amount of expansion, as half has already been allowed for in the length of the main.

* * *

CAUSE OF "ALLIGATOR SKIN" EFFECT ON DRAWN SHEET METAL

The peculiar mottled effect on the drawn sheet metal cup shown in the accompanying illustration is known in the sheet metal industry as "alligator skin." This marking is noticeable only when the metal is drawn or stretched to a considerable extent, as in the formation of a deep cup. There have been many reasons given for this effect.

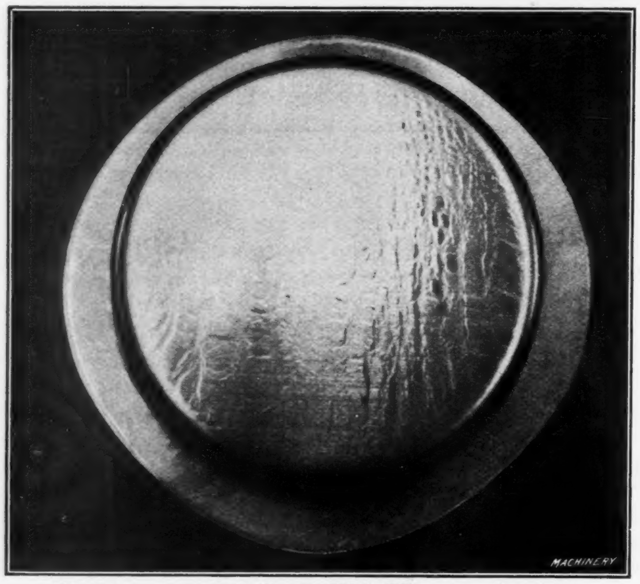


Illustration showing "Alligator Skin" Effect on a Cup drawn from Strip Steel that has a "Skin Hard" Surface

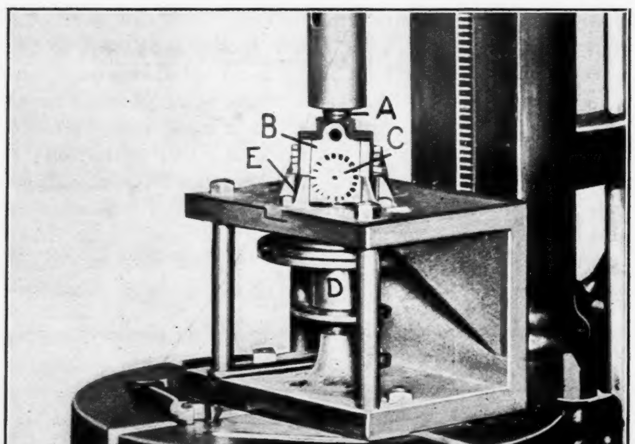
In producing cold-rolled strip steel, the material is annealed previous to the last rolling operation, so as to eliminate brittleness as much as possible. The last rolling operation serves to brighten the metal and bring it to the correct thickness. For some work, however, it is necessary to secure a grade of sheet metal known as "skin hard." This cold-rolled strip steel has a comparatively hard surface, and when the skin is not too deep produces bright and nicely finished cold-drawn work. However, it is much more difficult to work than the softer grades of steel, and is used only when a hardened surface on the material is desired. It is when "skin hard" strip metal is being drawn up that the "alligator skin" effect is produced. If the metal, after annealing, is reduced too much in thickness in the final rolling operation, a hard surface is formed on the exterior which is much tougher than the interior. Then when the metal, in being worked up to the desired shape, is drawn to a considerable extent, the interior or center portion of the cup draws much more than the outer surface; hence the outer surface, or hard skin, pulls apart, as it will not stretch anywhere nearly as much as the inside. This leaves a peculiar looking surface slightly depressed in those portions where the skin has broken away. In this particular cup which was drawn up from 0.037 inch sheet steel to a depth of 1½ inch and a diameter of 3 5/16 inches, the partings of the skin vary from 1/16 to 3/32 inch in width in those portions where the metal has broken away to the greatest extent. It will be noticed in looking closely at this illustration that the markings are much finer at certain points than others. This, no doubt, was due to imperfect alignment of the die and punch, which caused the metal to be drawn more on one side than on the other; consequently, the markings vary around the bottom of the cup.

It might be mentioned here that this "alligator skin" effect very seldom appears on soft sheet steel but is quite often present on "skin hard" steel. Manufacturers often find that this "skin hard" metal comes mixed up with soft stock, indicating that the rolling mill is at fault in allowing too much reduction in the final rolling operation. There is no possible way of eliminating this defect in the metal after it starts to appear. Of course "skin hard" metal can be drawn without producing this "alligator skin" effect if it is not reduced too much in thickness nor stretched to a considerable extent, but it cannot be removed by stamping or redrawing if it has once appeared. D. T. H.

* * *

INTERNAL MILLING ON DIFFERENTIAL GEAR CASES

For finishing the four inside faces of a differential gear housing, the New Process Gear Corporation of Syracuse, N. Y., uses the device shown on the drill press spindle in the illustration. The casting for the housing is first put through the different lathe operations, and then comes to the drill press for the finishing of the four internal panels that act as side supports for the bevel pinions of the differential mechanism. The housing is held in the jig shown on the table of the drill press, and the milling fixture is held in the spindle of the drill press. The milling fixture is held and driven by arbor *A*, about which is the square framework *B* which supports the four milling cutters *C*. These milling cutters are mounted on short shafts extending through the faces of frame *B*. On the inner ends of these four shafts are bevel pinions, in turn driven by a central bevel gear on the lower end of spindle *A*. The outer ends of the shafts or studs do not extend beyond the cutter faces. When the spindle is lowered so that the cutters enter the differential housing casting *D*, the corners of the frame *B* are engaged by brackets *E* and prevent the frame from turning. Continued down feeding permits the revolving cutters to finish the four faces. The amount of metal to be removed is about 1/32 inch from each face, and the principal work that has to be done is the sizing and finishing of the four faces. This method of milling takes care of what would otherwise be a troublesome job. C. L. L.



Fixture for Internal Milling on a Differential Gear-case

* * *

In the industries today, the one fundamental demand is for cooperation. There are men of rare technical knowledge, ripe experience and sterling honesty who have been total failures because they were always in a turmoil. They threw sand in the wheels of progress. Tact is the lubricant without which no efficient transmission of cooperative energy can be achieved.—*J. M. Eaton in the Journal of the Worcester Polytechnic Institute.*

LOADING AND "CLIPPING" CARTRIDGES*

TOOLS AND METHODS IN USE AT THE FRANKFORD ARSENAL

BY DOUGLAS T. HAMILTON†

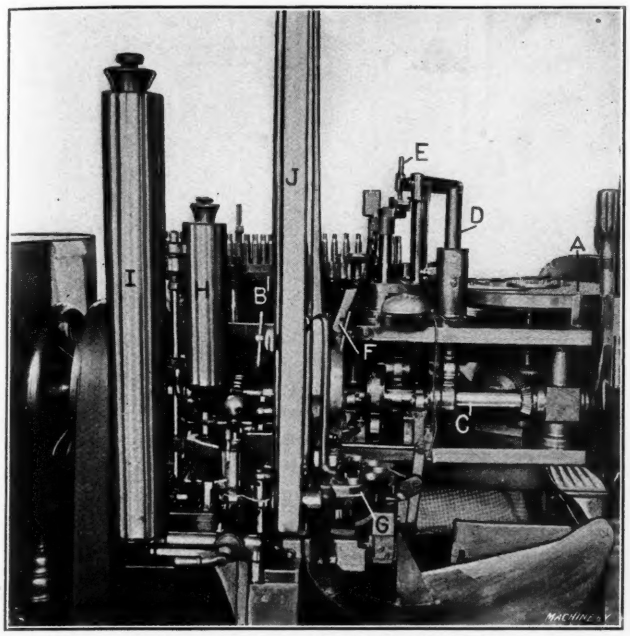


Fig. 1. Priming and waterproofing 0.30-Caliber Cartridge Cases

IN the March number of MACHINERY the development of 0.30-caliber cartridge cases from the sheet to the finished shell was described. The operations taken up were blanking, cupping, drawing and trimming. The heading of these cases has been described in a previous article (see the April, 1911, number of MACHINERY), so it will be unnecessary to go into this subject here. The method of priming 0.30-caliber cartridge cases in the Frankford Arsenal is different from that described in the article mentioned, so we will start from the priming of the cartridge, or in other words, placing the detonating cap in the head of the cartridge case.

Priming—Inserting the Detonating Cap

The head of the cartridge case, when being formed in the heading machine, is provided with a pocket, which is made by a teat on the end of the heading bunter. This pocket is approximately the same size—slightly smaller—than the diameter of the primer, and the inserting of the primer in this pocket is called priming. It is accomplished in the machine shown in Fig. 1. The primers are located, fifty or more at a time, on the dial *A* by the operator, and the shells are located on the dial *B* as illustrated. Both the dials are rotated, dial *A* being driven at a constant speed, while dial *B* is indexed by means of a ratchet dial in the usual manner. Over dial *A* is a spring that constantly vibrates, due to the friction of the dial rotating under it, so that the primers are agitated and gradually pass into a narrow channel, one at a time. As the shell reaches the priming point, a primer is carried out by a finger, held in line with the pocket in the shell, and then a punch operated from a cam-shaft forces the primer into the pocket. At the same time that the primer is being inserted the cam on shaft *C* operates plunger *D*, which through a fulcrumed lever actuates a padded punch *E* that holds the shells down while the primer is being inserted. After the primer is inserted, a finger knocks the shell from the dial down the chute *F*. From this chute it is deposited in a dial *G* which is also of the ratchet type.

* For information previously published on cartridge making see "Making Spitzer Bullets" in MACHINERY for April, 1914, and other articles there referred to.
† Associate Editor of MACHINERY.

Fig. 2. Inserting the Powder and Bullets and crimping—loading 0.30-Caliber Cartridges

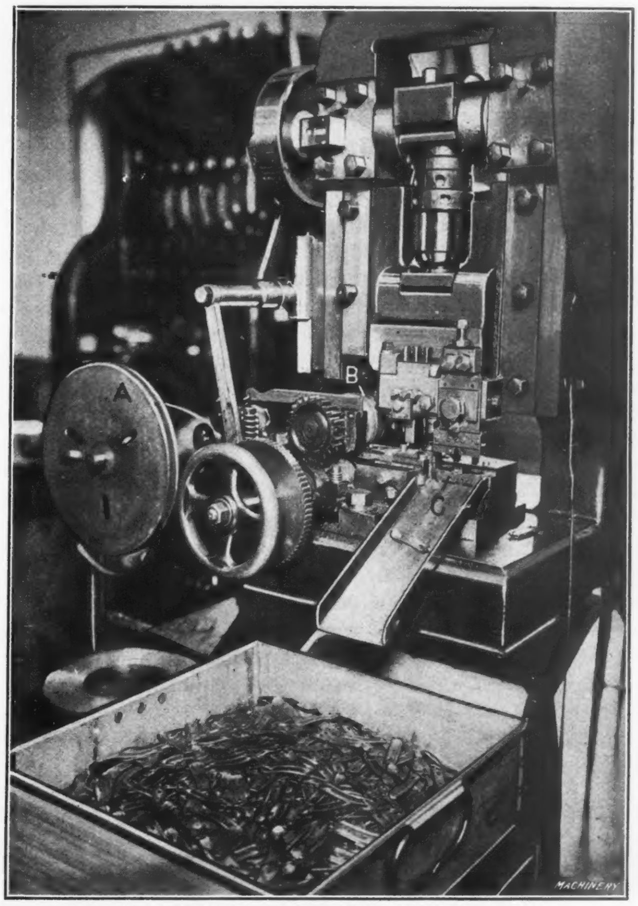


Fig. 3. A Machine used for making the Springs used in Cartridge Clips

The dial *G* is used as a medium for holding the shells while the mouth and primer end is being lacquered or waterproofed. The lacquer is held in tanks *H* and *I*, one tank supplying lacquer to a swab that enters into the mouth of the shell, whereas the other supplies lacquer to the swab that lacquers the primer and head of the shell. These swabs, of course, are operated in opposite directions, one going into the mouth of the shell and the other coming up against the head. Then as the dial indexes around, a ribbon *J* rotated on pulleys passes across the head of the shell and wipes the surplus lacquer from the head. The shell then drops out of the dial and is deposited in a box under the machine. The lacquer used for waterproofing the mouth and head of the shell is composed of shellac cut with alcohol and resin. The cartridge case is waterproofed so that it cannot become non-explosive if it should be dropped into water. The shellac that is applied is distributed around the rim of the primer and

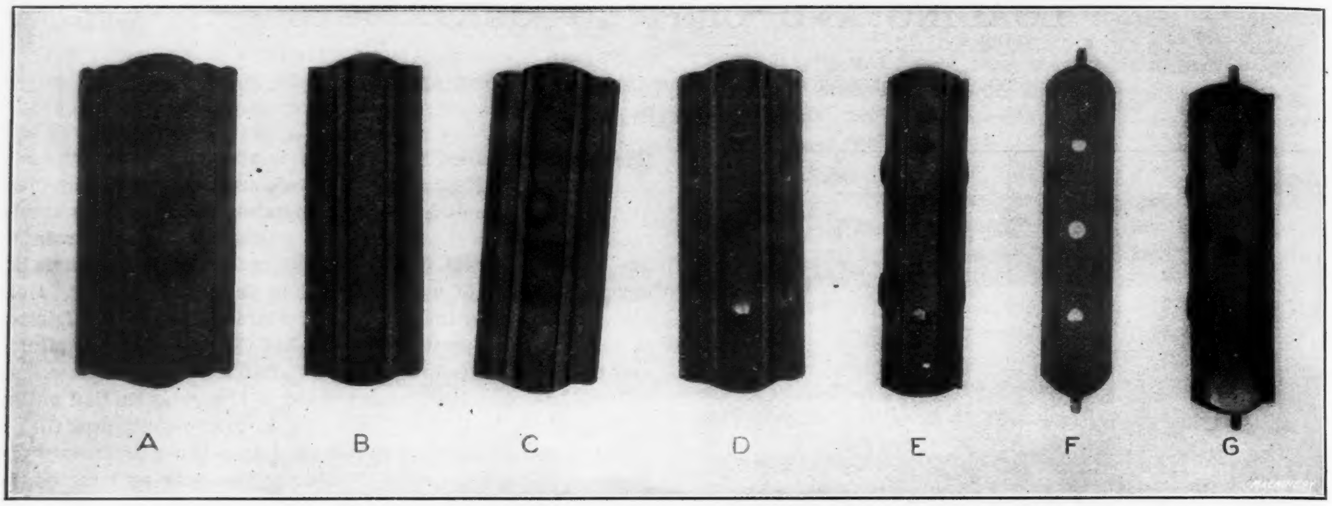


Fig. 4. Evolution of the Cartridge Clip that is used for holding Five 0.30-Caliber Cartridges

provides a protective coating. The lacquer deposited in the mouth of the shell after the nickel jacket bullet has been inserted serves the same purpose.

Loading

After the primers have been inserted in the cartridge cases, they are ready for loading. This consists in inserting the correct charge of powder and the bullet in the case, and then crimping the bullet into place. The cases are held in the box *A*, Fig. 2, from which they are removed by the operator and placed on a dial of the plain type. This dial carries the shells to the ratchet dial *B*, which, in turn, is indexed and presents the shells mouth up to the various loading containers and punches. The first action on the shell is to set it down properly. This is accomplished by a spring punch. Then the proper powder charge is inserted. The powder is held in the funnel-shaped container *C* and is removed from it by a slide operated by a crank motion. This slide comprises a small container that carries the correct charge of powder and deposits it in the shell in which it is packed by means of a punch. Then as the shell indexes around to the next position, a second charge of powder is inserted.

At the time that the operator is placing shells on the plain dial, he is also placing nickel jacketed bullets in the dial *D* with the points up. This dial is also of the ratchet type and after the powder has been put into the shell it is transferred from dial *B* to a position under dial *D*. Then a punch operated from a cam-shaft under the machine comes down on top of the bullet and inserts it in the shell. As the shell indexes to the next position, a crimping device turns in the top edge, holding the bullet in position. It is then ejected from the machine loaded.

Making Cartridge Clips

The device for quickly inserting cartridges in the magazine of a 0.30-caliber rifle consists of a clip which holds five cartridges sufficiently tight to prevent them from falling out. As soon as the clip is placed over the breech and the top cartridge pressed, they are ejected and pass into the magazine. The clips are thrown away after they have been emptied, so it is absolutely necessary that they be made very cheaply and at the same time in such a manner that they will not fail to perform their function. The main body of the clip is made from a sheet of brass stock about 0.021 inch thick by 2 7/16 inches wide. The sequence of operations necessary to complete this clip is illustrated from *A* to *G* in Fig. 4, and the machine for making the body of the clip is shown in Figs. 5 and 6.

Referring now to Fig. 5, which shows a front view of the press, the strip stock is held on a roll located at the right-hand end of the machine. The stock is fed into the machine by the ordinary type of feeding rolls, and the first operation is to cut out a blank as illustrated at *A* in Fig. 4. This is accomplished by the punch and die *B*, see Fig. 6. The blank is then ejected from the die and carried on to the next punch and die *D* and *E* by means of a transfer slide *C* similar to that employed in a multiple plunger press, that receives its motion from a crank mechanism at the left-hand end of the machine. The next operation, performed by the punch *D* and die *E*, is to form two ribs in the center of the blank, and turn up the two edges as shown at *B* in Fig. 4. The formed blank is then ejected and the transfer arrangement carries it on to the next operation, where punch and die *F* and *G* crimp the two outer edges into the condition shown at *C*. The edges of the blank are flattened down and at the same time turned up a distance about 3/64 inch above the top surface of the blank. The blank is then ejected from the die and is carried forward over die *H*. As punch *I* descends it forces the blank out of the transfer fingers and into the die *H*. This operation forms four projections which are shown at *D* in Fig. 4 that act as retainers for the spring to be inserted in later. The next punch and die *J* and *K* draw up the sides of the clip into box shape as shown at *E*. Then as the blank is passed on to the last punch and die *L* and *M* it is slightly curved and is ejected from the machine by a crank mechanism *N*, Fig. 5, which actuates the last die. This sequence of operations is carried on entirely automatically,

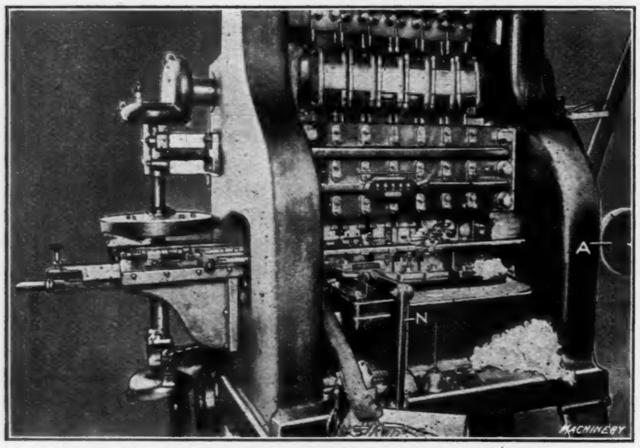


Fig. 5. The Cartridge Clip Machine—A Special Machine that completes the Body of the Clip in Six Distinct Operations

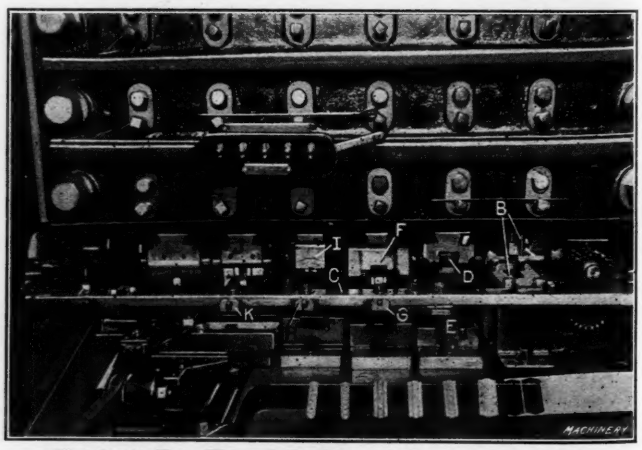


Fig. 6. A Close View of the Dies and Punches used in the Cartridge Clip Machine shown in Fig. 5

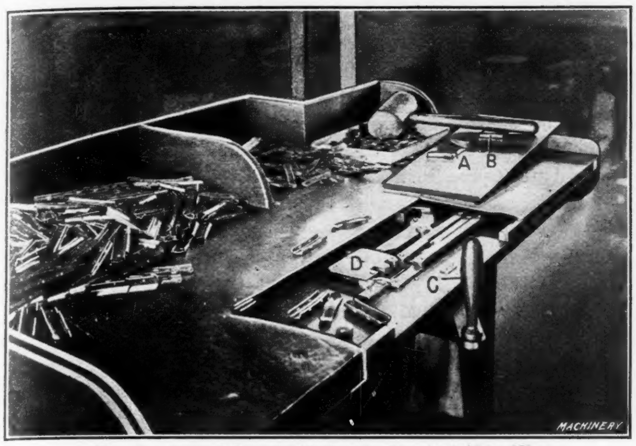


Fig. 7. Assembling the Spring in the Cartridge Clip

Fig. 8. Inspecting and weighing 0.30-Caliber Cartridges

and, in fact, the machine will run without any attention whatever until the roll has been exhausted. The operator then starts up the machine and the sequence of operations continues.

Making the Spring for the Cartridge Clip

In order to hold the cartridge in place in the clip, a curved flat spring *F*, Fig. 4, is used. This spring, which is made from a sheet of half hard brass stock 0.510 inch wide by 0.010 inch thick, is blanked out and bent to shape in the press shown in Fig. 3. The stock is held on a roll *A* shown to the left of the machine, and is drawn in by a pair of ordinary feeding rolls *B* operated by a ratchet mechanism receiving power from the crankshaft of the machine. The first operation is to cut off a strip to the required length, form the ends and pierce the three holes. This blank, by means of a carrier, is then transferred to the punch and die *C*. Here the blank is bent up into a curved shape and the spring prongs at each end are formed, after which it is ejected. These prongs are used in assembling the clips for holding the spring in place; they catch on a projection formed in the base of the clip. This machine is also entirely automatic in its operation, and when it is started will run until the roll of stock has been exhausted.

Assembling the Spring in the Cartridge Clip

The assembling of the springs in the cartridge clip is accomplished in the small bench machine shown in Fig. 7. The operator places the clip in a nest, then inserts the spring in a slide which carries it forward and inserts it in the clip. The spring is held on this slide and is pushed into the clip automatically by the prongs which fit into the raised catches in the clip. The clip is carried forward into the assembling position by another slide, which works beside the spring inserting plunger, and operates a carrier *D*.

In order to show the working mechanism of this machine, the top lid or plate that covers the mechanism has been removed, and is shown to the right of the illustration. The clip is inserted through the hole *A*, and the spring in the hole *B*. When the operator pulls the handle *C*, the slide advances carrying the spring and assembles it in the clip. After assembling, the clip is ejected from the machine and drops into a box placed beneath it. The assembled clip appears at *G* in Fig. 4.

Gaging, Weighing and Inspecting Loaded Cartridges

Before locating the cartridges in the clip, they are inspected, gaged and weighed. These three operations are all accomplished in one machine, which is shown in Fig. 8. The dies held in the dial *A* in which the cartridges are placed by the operator act as a gage for the body of the cartridge; that is, the contour of the holes in these dies is similar to the chamber of the rifle. As the dial passes around, the cartridges are carried beneath an electrically operated plunger which inspects them to see that each one has a primer in it. Should a cartridge be encountered that has no primer, this punch drops down into the pocket and breaks the electric circuit, which causes a bell to ring, thus notifying the operator that a cartridge with no primer has passed. When the primer is located upside down, the same action takes place.

The weighing of the cartridge is accomplished in a unique and interesting manner. As the dial *A* passes around, the cartridge is lifted up and caught by the ejector *B*. This transfers the cartridges to the scoops *C* which are carried on the weighing dial *D*. The weighing is done by balances *E* in which the cartridges are deposited by the scoops *C*. The bullet comes up to a stop in these balances and a wire hook attached to the balance catches on the wire *F* when the cartridge carries the correct charge of powder and dumps the cartridge into the box *G*. When the charge of powder in the cartridge is light the hook on the weighing balance *E* rides up over wire *F*, but as the dial passes around still further the hook catches on a wire located higher than wire *F*, and dumps the cartridge into the light charge box. It is therefore evident that cartridges which are light in weight pass the first box, but cannot go completely around, as they are ejected by the second wire, thus making certain of dumping the weighing balance and throwing the cartridge out. This mechanism successfully eliminates all light charge cartridges, and keeps them uniform in shooting quality.

Inserting Cartridges in the Clips

The machine used for inserting the cartridges in the clips is shown in Figs. 9 and 10. A dial *A*, which accommodates

Fig. 9. Cartridge Clipping Machine—assembling the Cartridges in the Clip

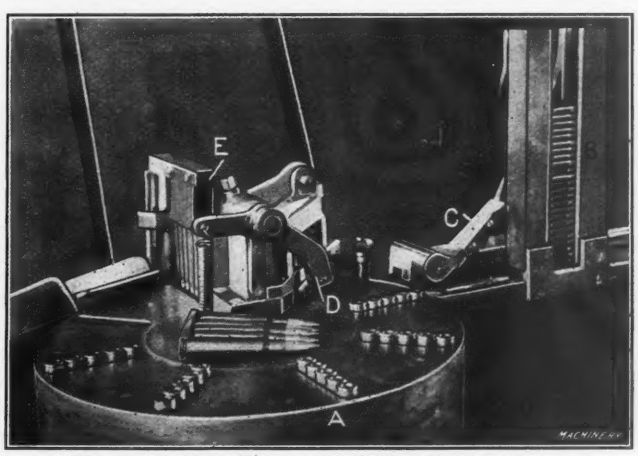


Fig. 10. A Closer View of the Machine shown in Fig. 9, illustrating the Operating Mechanism

five cartridges in a row, carries the cartridges around to where the clip is inserted over them. This dial is rotated by means of a crank motion, pawl and ratchet in the ordinary manner, the ratchet dial being located beneath the dial carrying the cartridges. The assembled clips are placed in the proper position in the magazine *B* by an operator; two operators are engaged in keeping the cartridge dial full. The clip is carried out from the bottom of the magazine by means of a carrier operated by an eccentric shaft, and is located over the five cartridges in the dial *A*. The "latch" *C* which is shown thrown back in the illustration runs under a roller held in bellcrank *D* and seats the clip properly on the heads of the cartridges. The dial then indexes to the next position, where a bending tool comes into action and bends down the prong projections on the ends of the spring in the clip, thus preventing the cartridges from dropping out. As the dial then indexes around to the next position, the cartridges that have been inserted in the clips are picked up out of the dial by means of a swinging transferring arm that drops them in a box. 65,000 of these cartridges are inserted in the clips per day of eight hours. Fig. 10 shows a closer view of the machine illustrated in Fig. 9, and gives a better view of its construction and operation. Here it will be seen that the ejecting or work-removing fixture is composed of two pieces of sheet steel, spring tempered, which grip the clip by the lower surface.

* * *

FROM THE CELLAR UP*

When a small boy, not yet in my "teens," I sought and obtained employment in an old Connecticut "hame" factory. I had visions of wealth that I would gain from my industry, and entered the employ of an old-time contractor, who, among other things, did the polishing of the metal work on hames. He used wooden wheels covered with leather and coated with glue and emery. A large part of my work was to "wash" or soak off the glue and emery from the worn wheels preparatory to re-coating.

I wish it were possible to show a photograph of the place and the facilities—a low, dark cellar, among rats and mice, where never a ray of sunlight entered. A small leak in the old waterwheel flume furnished the water supply. I had to hold the wheels and turn them gradually so that the coating of glue and emery might soak away. It was a tedious and ambition-killing process for a boy—holding one wheel at a time and slowly turning it to bring all parts of the circumference under the stream.

I can recall how injured my feelings were when I believed I was competent to perform the skillful mechanical work up in the shop above, and how I planned various protests, the language of which I readjusted from hour to hour, that it might be convincing when the auspicious moment for its utterance should arrive.

At last the injustice of my treatment became so great in my mind, and the foolishness and wastefulness of such labor so plain to me, that the invention of a machine for doing the soaking automatically kept rising uppermost in my brain, until I forgot my eloquent protest and fell to studying out the great invention. I forgot all about the fact that I was slowly turning in my hands the wheel that was soaking. I forgot all about the darkness and loneliness of my workshop in the mental visions of the machine that was to wash a dozen or more wheels in the time that I was washing one, and was to do this while I was employed at more useful and more interesting work above.

At last, when my vision was complete, full of hope and visions of progress, I summoned up my courage to explain it all to my employer. Alas! I did not know that I was then to learn my first lesson in opposition to progress. My employer laughed and several others with him. The impossibility of washing a dozen wheels at once and without labor was too clear to them to admit a doubt. Little did I realize then that this opposition was only the beginning of what my life should encounter in the introduction of new designs and processes. Little did I then understand that all progress must be made in the face of opposition from those who, it would be natural to suppose, would be most interested in it.

I then also learned my first lesson in false economics. I was informed that if such a machine could be made to work, I would be out of a job. I replied that I could be employed at some of the more interesting work in the shop. I was informed that there would then be no work for someone else. They were too much for me then, but I could not get over the belief that, with the washing machine in operation, I could be more profitable and my work more interesting. I was crestfallen. My invention was turned down by my employer. I was laughed at. I stole away quietly and waded in the pool under the waterwheel that was then still for the noon hour.

Time and change have wrought their wonders since then. The old "hame shop" is gone. A fire destroyed it years after, and the place where I worked, alone in the darkness, is now uncovered to the sunlight and the wild flowers bloom there. Fifty years have passed since then, and my washing machine has become a reality. Today there are many of these machines in use, and no boys are washing buffing wheels by hand.

In view of this, the facts I would impress upon young men are: First: That while the first struggles determine it afar off, final success in life comes not at the beginning of life, when one is young, but only after years of hard, patient work. Second: To succeed as a leader and creator of useful things, that help the world to a higher and better life, whether it be the designing and invention of machinery, methods, ideas or changes in any form, one must always encounter the opposition of both high and low, the educated and the ignorant. Third: The greatest reward comes by the way of one's own inner consciousness of having accomplished something to help the very world that has opposed him. For it is true that few men who really create the ideas and improvements that make the world better, receive frank recognition from those that their efforts have helped most.

* Abstract of an address delivered before the Boys' Vocational Club, Worcester, Mass., by Charles H. Norton.

* * *

LOAD CAPACITY OF BALL BEARINGS

In a lecture recently delivered before the Institution of Automobile Engineers (Great Britain), Prof. John Goodman, of Leeds University, dealt with the design of ball bearings. The lecturer has given the subject considerable attention for the past fifteen years, during which time he has conducted many experiments on this type of bearings. One result of his investigations has led to the establishment of the following formula which gives the maximum working load in pounds to be allowed for any given ball bearing:

$$\frac{Kmd^2}{ND + Cd}$$

where

m = the number of balls in the bearing;
d = the diameter of the balls in inches;
N = revolutions per minute;
D = diameter of ball race, taken from the point of contact of the ball with the outer race (for a thrust bearing D = the diameter taken from the centers of the balls).

The constants C and K are as follows:

For thrust bearings:

	C	K	
Flat races	200	500,000	
Hollow races	200	1,000,000	when the radius of the race is about twice that of the ball;
		1,250,000	when the radius of the race is about 9/16 that of the ball.

For journal bearings:

	C	K	
Flat races	2000	1,000,000	
Hollow races	2000	2,000,000	when the radius of the race is about twice that of the ball;
		2,500,000	when the radius of the race is about 9/16 that of the ball.

THE INSIDE OF THE MAGNETIC CHUCK—2

CHUCKS FOR VARIOUS PURPOSES AND PRINCIPLES OF DESIGN

BY HERBERT L. THOMPSON*

THE chuck shown in Fig. 8 is a simple rotary chuck for use in the lathe. Soft Swedish iron should be used in its construction, and if well made it will hold strongly enough for grinding, light drilling, boring and facing on such work as master plate blanks or sub-press dies. If provided with tapped holes in the face, it becomes what might be called a semi-magnetic faceplate which is very convenient for any work that must be indicated for location. The piece to be machined is held on the chuck by the magnetism and tapped with a soft hammer until located, after which clamping straps are applied so that severe machining operations can be performed. The general shape of the magnetic circuit in this chuck is similar to that of the one in Fig. 5, though, of course, this chuck is cylindrical while the one in Fig. 5 is rectangular; but the single coil and enclosing iron carry out the same idea. The hub, base and core are one piece, while the cover *A* comprises the outside magnetic circuit, both poles, the gap and filler. The cover *A* is pressed onto the shoulder of the base at *B*, and held in position by the screw *C*, which must bring the center pole piece and the end of the core into close contact at the same time that the rim of the cover completely engages the shoulder at *B*. The gap line is shown square, and the anchor spots *E* are milled into the edges of both pole pieces to retain the filler alloy. It will be noticed that the polar gap is wider at *F* than it is on the active face of the chuck; this is to increase the magnetic resistance of the gap, and prevent the magnetic current returning across the inner side of the gap as far as possible. This widening of the gap on the unused side of the poles is good practice with any chuck, and will materially increase the holding power of the chucking surface.

The coil for this chuck is not form wound. Being adapted for attachment to the lathe spindle, it is a simple matter to wind the coil directly onto the paper insulating sleeve *G* on the core *H*. The paper washer *I* prevents the wire in the coil from coming in contact with the base of the chuck; and the fiber washer *J*, which must be glued to sleeve *G*, holds the winding in place until the cover is attached. As a rotary chuck must revolve, it is impossible to attach it to the electric supply in as simple a manner as could be used for any kind of a stationary chuck. Some kind of moving contact must be provided, and nothing could be much simpler nor more efficient than the brushes and collecting rings shown in the illustration. The piece *K* is a fiber bushing bored to press snugly onto the hub of the chuck, and shouldered at each end to accommodate the two brass rings *L* and *M*. At diametrically opposite sides of the bushing *K* are milled the channels *O* and *P*, through which the ends of the coil wires are brought for attachment to their respective rings. The fiber bushings *Q* and *R* are provided to insulate the wires where they pass through the base of the chuck. The service wires are attached under the heads of the binding screws *S* and *T*, and current enters the coil through the brass brush *U*, the ring *M* and the wire through bushing *Q*. It leaves by the wire through the bushing *R*, the ring *L* and the brush *V*, after passing through the coil. The fiber base *W* may be of very different shape, and can be attached to the bed or the headstock of the lathe, depending upon which is most convenient.

Winding a Rotary Magnetic Chuck

To wind this chuck, it is necessary to remove the cover and have the insulating washers and sleeve in place with the glue dry. A short piece of single strand lamp cord is soldered into a hole through the ring *M* and passed through the bushing *Q*. The other end of the lamp cord is then firmly soldered to the end of the magnet wire of which the coil will be made. The reason for using the lamp cord is to provide a strong lead to the inside wire of the coil, as a slight slipping of the ring would probably break the frail magnet wire, which would make it necessary to entirely unwind the coil for repairs. For the same reason the lamp cord should be left as loose as possible, as a little slack may be necessary later on if the cord should become disconnected from the ring. The soldered connection between the magnet wire and the cord should be taped to insulate it from the rest of the wire, and the lamp cord should have at least one turn about the core to prevent any outside pull from bringing a strain directly upon the end of the magnet wire.

Magnet wire is always sold on a wooden spool, and this greatly facilitates the winding of coils in the lathe. A piece of half-inch rod should be fastened in a horizontal position, so that the wire spool can revolve freely upon it. After taping the junction of the lamp cord and magnet wire, the first few turns of the wire should be wound while turning the lathe by hand, so that the wire will bind the core and not slip when the speed is increased. The lathe can now be started by power, and the operator should feed the wire to the core as evenly as possible, in the same way that an old fashioned sewing machine bobbin is wound. It is far from necessary to lay each layer of wire exactly even, but it must be borne in mind that it is very advantageous to have as much wire as possible in the available space. For this reason, the coil should be revolved with considerable speed, and care should be used to prevent too much crossing of the successive convolutions. The winding should be continued until the wire is even with the opening in the bushing *R*, after which it is cut and passed through the bushing to be soldered into a slot in the edge of the ring *L*. No lamp cord is used on this terminal, as a break could easily be found and remedied without unwinding, and one turn of wire from the coil is sufficient to repair any break. After all connections are made, the coil should be wound with a layer of friction tape to prevent unevenness in the winding, and to keep centrifugal force from causing the wire to touch the inside of the cover and short-circuit the coil when the chuck is running.

If the chuck shown in Fig. 8 is wound for service on a voltage as low as twenty or lower, it is possible to simplify the construction to some extent by using the frame of the chuck and lathe as one of the electric terminals. Instead of using the ring *M* and brush *U*, the inside coil-end is simply fastened under a screw head anywhere on the iron part of the chuck, and the service wire that would be attached at binding screw *T* can be fastened under any screw head on the lathe. This arrangement brings the lathe and chuck into the electric circuit, and for this reason would be extremely dangerous on the higher voltages; but as a severe shock is impossible on twenty volts, it is here permissible and a real economy. The brushes and rings should always be kept clean, and especially free from chips or soldering acid, as either will be apt to short-circuit the chuck. A guard or shield of some kind protecting the rings and brushes is desirable if the voltage is high, as even 110 volts is unpleasant to handle with perspiring hands. It is a good idea to paint the exposed electrical connections with asphaltum, as a measure of insulation, but of course, this cannot be applied to the rings and under sides of the brushes.

Magnetic Lathe Chuck for Severe Service

For lathe work of a kind requiring fairly severe machining, it is possible to secure excellent results by the use of a chuck like that shown in Fig. 9. This differs from all the previous chucks in that it is strictly multipolar, having six independent cores and coils of alternate polarity, each attached to its own individual pole piece. A chuck of this description has many advantages over one provided with any form of bi-polar magnet, but is so much more expensive to make that it would be extravagant to use it on any work that

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could be handled on the cheaper and less complicated forms previously described. For master plate and fine die work, such as is commonly done on the bench lathe faceplate, this chuck is ideal. It will hold very strongly, and will give absolutely accurate results because there is no distortion due to clamping, as is invariably the case to some extent with the ordinary faceplate. Needless to say, it will save an enormous amount of time in setting up and locating.

If one considered the expense of making this chuck entirely of Swedish iron too great, the base *A* and enclosing frame *B* could be made of gray iron to good advantage, but in any case it is necessary to machine every part all over and very accurately. The cores *C* and the pole pieces *D* should be made of Swedish iron, and as they are by far the

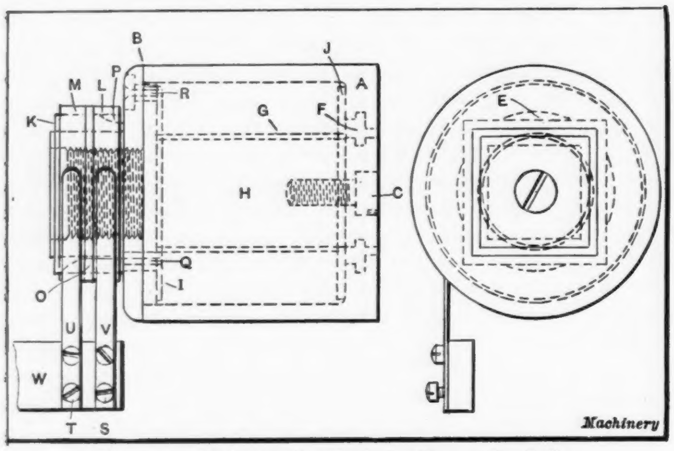


Fig. 8. A Semi-magnetic Chuck for Use on the Lathe

most important part of the magnetic circuits, the gray iron base will have but slight influence upon the holding power. The center piece *E* is a brass bushing provided with a tapered hole to hold a center pin for master plate work. It is threaded into the polar face of the chuck so that the tapers can be driven in or out without danger of dislodging the bushing. The cores *C* are firmly pressed into the holes in the base of the chuck, and it is very essential that these holes should be carefully indexed and bored, to insure a nice running poise for the finished chuck. The pole pieces *D* should all be made exactly alike, special care being taken to have the screw hole very accurately located. As the filler alloy is quite a factor in the strength of the polar face of this chuck, anchor spots similar to those illustrated at *E* in Fig. 8 should be milled into the edges of both the pole pieces and the enclosing frame. To apply the filler to this chuck, it is necessary to completely assemble the iron parts, locating the pole pieces with reference to the frame and each other as carefully as possible. The whole chuck can now be laid on its polar face while the molten alloy is poured in from the back through the threaded hole *F*. This binds the seven pieces of iron composing the cover together, so that the pole piece screws now hold the frame in place as well.

The coils for this chuck may be form wound, or they might be wound on separate wooden or paper spools, but in any case the finished coils must weigh the same. In connecting them up it is important for the electric current to pass around each in alternate directions, as shown in the illustration. In a multipolar magnet there are a number of separate magnetic circuits, and to secure the best results adjacent poles should always have alternate polarity. If a piece of work were laid across a gap between two poles of like polarity, it would be repelled instead of attracted; but if it also covered part of even one pole of opposite polarity, the attraction would become intense from all three. For this reason it is wise to make small sized pole pieces, so that very small work will be able to cover part at least of several of them. This is one of the excellencies of this chuck; it has a gap of intricate shape, but not of undue length for each pole piece, and it is possible for a small piece of work at the center to cover part of all six of the pole pieces. A magnetic circuit is also established if work is laid across the gap between the frame *B* and any of the poles; this is a valuable feature, as it makes the whole face of the chuck active. Its worth would be appreciated by anyone who finds it necessary to counterpoise a faceplate job on this chuck. What was said about the rings, brushes and terminal connections of the chuck in Fig. 8 applies equally to this case, as they are identical for any rotary chuck. The bushings *G* and *H* in Fig. 9 serve the same purpose that those shown at *Q* and *R* do for the chuck in Fig. 8, and as all of the coils in Fig. 9 are connected in series, there are but the same two terminals, though there are six coils.

Fig. 10 represents a multipolar chuck somewhat similar to that in Fig. 9, but made for use on the planer or milling machine. It is considerably easier to make than the chuck illustrated in Fig. 9, because it is not necessary to poise it. Gray iron can be used entirely in its construction, or the cores and pole pieces may be composed of Swedish iron to some advantage if exceptional holding power is desired. If made of gray iron only ten pieces are necessary, while if Swedish iron is used for the cores and pole pieces, it will take eighteen pieces of iron all told. This chuck differs from the one in Fig. 9 in that the frame *A* of the top plate extends between each pole piece, so that each pole is separated from its neighbor by two thicknesses of filler and a section of the frame. This adds something to the magnetic resistance of the gaps, and as the frame is active to work that is in contact with any one of the poles and to thin pieces that cover any number of poles, there is some advantage in this construction.

A chuck of this kind is particularly adapted for general tool work when large and small pieces of various shapes are to be held. It will hold extremely thin pieces better than any other kind of magnet would, and the active surface of the chuck face is so well distributed that work can be held upon any part of it. This chuck will stand the roughest kind of use, and being entirely iron bound, neither water nor oil will harm it if well made. It can be made in various shapes and sizes to accommodate special work, and though it is more expensive than some of the simpler shapes, it will also hold some forms of work for operations that would be impossible with a cheaper kind of magnet. Form wound coils can be used on this chuck, and they should be connected in series in such a way that alternate polarity will result in each suc-

Fig. 9. Multipolar Magnetic Chuck for Heavy Lathe Work

cessive pole. In attaching the coil terminals to the leading-in lamp cord, great care must be exercised to have both connections well taped for insulation; and to prevent accidental pulls on the cord from breaking the magnet wire, a knot should be tied in the cord large enough to prevent its being pulled through the bushing. Care in this particular will prevent frequent trouble from broken connections inside the chuck. This applies to any of the chucks described, as well as the one shown in Fig. 10.

Making Form-wound Coils

For winding the coils of any of these chucks, except the ones shown in Figs. 8 and 9, some kind of form is necessary, and Fig. 11 shows one made of wood that is quite satisfactory. It is about the right shape for the coils of the chuck in Fig. 6, but of course could as well be made any other shape. To use this form, place it between the centers

of the lathe and arrange a small dog or a stud on the face-plate to drive it. Support the spool of supply wire in front of the lathe, as when winding the coil for the chuck in Fig. 8. Insert three or four inches of the magnet wire under guide *A* at *B*, and wind several turns of it about the form, by hand, to prevent slipping. The winding can now be continued by power until the coil is brought to size. After stopping the lathe, and before cutting the wire, the coil should be wound with friction tape on both sides, so that it will retain its shape after being removed from the form. The slots in the form and guides permit this to be done very readily, after which the wire is cut and the form removed from the lathe. The pins *C*, *D*, *E* and *F* are now withdrawn from the guides *A* and *G*, and the coil can be pressed off the form with the guides. The form being tapered somewhat,

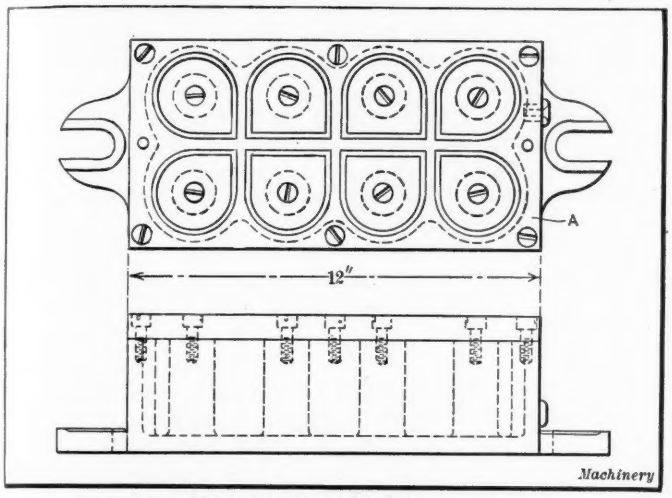


Fig. 10. Multipolar Chuck for Use on the Planer or Milling Machine

allows this to be accomplished quite easily without harming the insulation of the wire. Tape should now be applied to the whole coil until no wire is exposed except at the terminals, which should be left long enough to make connecting an easy matter. If all the coils are always wound in the same way, the terminals will issue from the coil in the same relative positions. This will facilitate connecting, as the direction in which the coil is wound can always be seen at a glance by the position of the terminals. Enameled wire is to be recommended for winding magnetic chuck coils, as it has many advantages over fabric insulation.

Principles used in Designing

In the foregoing descriptions of magnetic chucks, no mention was made of the reasons for the proportions used, nor were any rules given for establishing the size and quantity of wire to employ. These are, of course, matters of the greatest importance, and while experiment will often show opportunities for improvement in any predetermined winding, it is an easy matter to establish at least the size of the wire.

To secure maximum holding power, the cores for any magnet should be at least equal in cross-section to the work to be held. This means that the magnetic circuit should never be constricted to a smaller cross-section than the maximum of that part of the work through which the magnetic current flows when in place on the chuck. In case of a bi-polar chuck having cores on each side of the gap, it would mean one half of the cores. With a single coil chuck it would mean the total cross-section of the one core, and in the case of a multipolar it would mean one half as many of the cores as were actually engaged with the work, though in most cases such chucks are made for general purposes, and the core sizes become more a matter of judgment than of rule. The cross-section of the remainder of the magnetic circuit should exceed this, if weight or size is not an objection, as the lowest possible magnetic resistance is to be desired. Considerable latitude is permissible in the shape of the cores for any magnet. The greatest magnetic effect is obtained from the wire nearest the core, and for this reason a long core which would allow of a great quantity of wire in the first few layers would have this advantage, but as it would have the disadvantage of increased magnetic resistance due to its greater length, no real gain would result. A cylindrical core of a length greater than six or eight times its diameter will leak magnetism badly through the air, and the length can be carried to such extremes that practically all of the current will be absorbed in this way. On the other hand, a core could be so short that there would not be enough room for sufficient wire adjacent to it to magnetize it to any extent. Generally speaking, it is well to make cylindrical cores about twice as long as their diameters, and they should be energized by a coil not larger than three times the diameter of the core. That is, the winding must not be thicker around the core than the core diameter. If a greater cross-section is needed than can be secured by a cylindrical core of correct proportions in the space available, it is advisable to use an oblong shape as in Figs. 5, 6 and 7, and the windings should not be thicker on one side than the smaller diameter of the core.

Weight of the Required Wire

When the iron parts of the chuck are finished, and the size of the coils has been determined, it becomes necessary to discover the proper size of magnet wire to use in the coils to accommodate the voltage of the circuit upon which the chuck will be used. The weight of wire necessary to make one coil must first be found. To do this, pick any large size wire from a table of dimensions of copper wire, which can be found in almost any electrical or mechanical handbook. Find the diameter of the wire from the table, and see how many times the diameter is contained in the length of the core to be wound. This will give the number of turns to one layer, and the thickness of the coil divided by the diameter of the wire will give the number of layers. Multiply the number of layers by the number of turns in one layer and we have the total number of turns. Find the length of one turn of the wire in the middle layer; this will approximate the average length of all the turns, and the total length of the wire on one coil can be found by multiplying the average length of one turn by the number of turns. Having arrived at the total length of the wire, its weight can be found from the table under the heading "Weight and Length." The actual weight of the coil will be about three-fourths of that found, as some allowance must be made for insulation and the crossing of the wires in winding. The weight of a coil of given size will be the same, regardless of the size of the wire

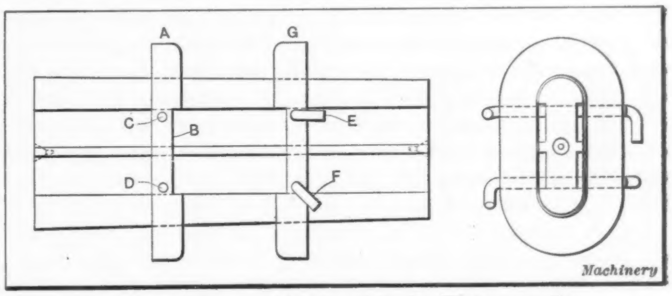


Fig. 11. Form on which the Coils for Electromagnetic Chucks are wound

used, so a haphazard choice of a size for experiment is permissible. Having the weight of one coil, the weight of all of the wire on the chuck can be found by simply multiplying by the number of coils.

The passage of an electric current through a wire is always attended by some heat, and too much current will cause a rise of temperature sufficient to ruin the insulation of the wire. For this reason, the wire to be used on any magnet must be of such size that the quantity required for the coils will have sufficient resistance to prevent the voltage used from forcing more than a safe amount of current through it. Ohm's law states that the current in amperes in any circuit is equal to the number of volts acting on it divided by its resistance in ohms. From this, it is an easy matter to find the amount of current that any voltage will force through the chuck coils after the wire size is established, so that its re-

sistance can be found from the table. Small magnet wire should carry from 1500 to 2000 amperes per square inch of cross-section without undue heating. Knowing the safe carrying capacity of the wire per unit of cross-sectional area, the weight of wire required for the coils and the voltage upon which the chuck is to be used, no further data is required for finding the wire size.

In the "Ohms per pound" column of the wire table, find such a resistance that, when the voltage to be used is divided by it, the result will give a quotient in amperes close to the safe carrying capacity of the wire which it represents. The cross-sectional area of the wire is always given in the table. There will be considerable difference between the results obtained from wire sizes next to each other, and it may not be possible to find a size that will be just right for the size coils in hand. If this is the case it will generally be safe to use the next size larger, because if the coils did heat to some extent, it would be an easy matter to add a few extra layers of wire to the coil, which would bring the resistance up to that required.

WIRE TABLE OF SIZES SUITABLE FOR MAGNETIC CHUCKS

Number B. & S. Gage	Diameter in Inches	Area	Capacity in Amperes	Feet per Pound	Ohms per Pound
11	0.090742	0.00646706	9.7 -9.12	40.11	0.05054
12	0.080808	0.00512860	7.6 -9.7	50.58	0.08036
13	0.071961	0.00406709	6.1 -7.6	63.78	0.12778
14	0.064084	0.00322544	4.8 -6.1	80.42	0.20318
15	0.057068	0.00255785	3.8 -4.8	101.40	0.32307
16	0.050820	0.00202843	3.2 -3.8	127.87	0.51373
17	0.045257	0.00160865	2.5 -3.2	161.24	0.81683
18	0.040303	0.00127575	2.0 -2.5	203.31	1.29876
19	0.035890	0.00101166	1.6 -2.0	256.39	2.06531
20	0.031961	0.00080224	1.2 -1.6	323.32	3.28437
21	0.028462	0.00063624	1.0 -1.2	407.67	5.22177
22	0.025347	0.00050460	0.85-1.0	514.03	8.30181
23	0.022571	0.00040012	0.68-0.85	648.25	13.20312
24	0.020100	0.00031731	0.53-0.68	817.43	20.99405
25	0.017900	0.00025165	0.42-0.53	1030.71	33.37780
26	0.015940	0.00019956	0.33-0.42	1299.77	53.07946
27	0.014195	0.00015826	0.26-0.33	1638.97	84.39916
28	0.012641	0.00012550	0.21-0.26	2066.71	134.2005
29	0 011257	0.00009952	0.17-0.21	2606.13	213.3973
30	0.010025	0.00007893	0.13-0.17	3286.04	339.2673

Machinery

Method of Determining Wire for a Given Voltage

As an aid in figuring the wire sizes for different voltages the table above is given for the range of sizes most likely to be used in magnetic chuck work; and in addition to the usual data, it includes a "capacity column" in which the safe range of load for each size wire is given. To illustrate the method of finding the wire size for a given voltage, take for example a chuck designed with four coils, the cores of which are to be cylindrical in shape, 1½ inch in diameter and 2½ inches long. Space should be provided for a depth of winding of ¾ inch and this is to be filled with wire of the proper size to accommodate 20 volts. Referring to the wire table, find a wire of rather large size whose diameter will be nearly evenly contained in the depth of the coil winding ¾ inch. No. 15 answers very well in this case, as it has a diameter of 0.057068 inch bare and with the insulating enamel on would come very near to 1/16 inch. This is contained in the winding depth ¾ inch twelve times, so it will take twelve layers of No. 15 wire to complete a coil, and as 1/16 is contained in the core length 2½ inches forty times, there will be that many turns of wire in each layer. If there are twelve layers of forty turns, each coil with contain $12 \times 40 = 480$ turns in all.

As there is to be a depth of wire on the cores of ¾ inch, a turn of wire that lies at half this depth or ⅜ inch from the core will have an average length. This length can be readily found by multiplying the diameter of the turn in question, which is 2¼ inches, by 3.1416. This gives a length for one turn of 7.0686 inches, and multiplied by the number of turns, 480, gives a total length for the No. 15 wire on one coil of 3393 inches, or practically 283 feet. Referring again to the wire table, No. 15 wire is found to run 101.40 feet to the pound, so dividing 283 feet by this value gives approximately 2.8 pounds as the weight of wire of any size that one coil will contain. As the chuck in question has four coils, the total amount of wire required will be 11.2 pounds. Having determined the weight of the wire for the entire chuck, it remains to find a size of wire that will have the correct resistance for the voltage. This resistance must be such that 20 volts will have just sufficient pressure to force the safe carrying capacity of the wire through it. Taking as an experiment the same No. 15 wire, 0.32307 is found in the wire table to be its resistance in ohms for one pound. Multiplying this by 11.2 gives 3.6 ohms as the resistance for the entire chuck. To find the current this will allow to pass, it is only necessary to divide the voltage, 20, by the resistance, 3.6. The result is 5.5 amperes, and as the wire table gives the capacity of No. 15 wire at from 3.8 to 4.8 amperes it is plain that a smaller wire will be needed for this chuck. Taking No. 16 as next choice, 0.51373 is given in the table as its resistance for one pound, or 5.7 ohms for 11.2 pounds. Dividing the 20 volts by this resistance gives 3.5 amperes, which is well within the capacity 3.2–3.8 given in the table for No. 16 wire. Therefore this chuck will require a winding of 11.2 pounds of No. 16 wire, to operate at 20 volts.

If the chuck were to be used on any other voltage, proceed in the same way to find the wire size, but it must be understood that these sizes, as found, can often be improved upon by experiment. For instance, a chuck having oblong cores of large size and a heavy base in close contact with some heavy machine platen could stand a heavier load on its wire than a light weight enclosed chuck for use on a lathe. In the first case, the excess heat would be rapidly carried away by the heavy parts, while in the light chuck it would simply accumulate. Again, some chucks may be made for very short operations with longer idle intervals. In such cases, lighter wire than called for by the load may be employed with good results, as insufficient time will be allowed for dangerous heating. No rule can be given for securing a certain holding down pressure, as conditions vary considerably in every case. A chuck that would hold a 6 by 12 by 2 inch block of iron with a pressure of 200 pounds to the square inch would not hold a piece the size of a dollar with nearly that strength. It can be said, however, that any of the chucks illustrated should hold a flat piece 1 by ½ by 6 inches strongly enough so that a very strong man could not move it with his hands.

It is very unlikely that perfect results are ever secured in winding coils for a certain voltage without some experimenting. The amount of current a coil of a given sized wire will stand varies with different conditions. The shape and size of the coil, the weight and shape of the core, the kind of insulation used and the opportunity given for air circulation are some of the factors in determining the heating properties of any chuck. A mild warmth after the chuck has been in use continually for an hour or so is not objectionable; in fact, this would indicate good results.

Method of Connection to Circuit

For connecting the finished chuck to the current supply, ordinary drop cord is very satisfactory. It should be soldered to the coil terminals and very carefully taped at the splice. Some sort of switch must be provided, preferably one that will allow reversing of the current to demagnetize the chuck when large work is being held, as the temporary residual magnetism is likely to be very strong in a gray iron chuck. A double-pole, double-throw, knife switch fulfills these requirements nicely; such switches are easily obtained and quite inexpensive. There are six binding posts on these switches, two in the center to which the blades are attached, and two at each end into which the blades engage when thrown in either direction. The drop cord from the chuck should be attached to all four of the end poles, each separate conductor being scraped and fastened to one binding post on the near end of the switch, and then brought diagonally across to the post on the extreme opposite end and attached. The service wires enter the binding posts in the center of

the switch—the same ones to which the blades are pivoted. Closing the switch into cne pair of the end posts allows current to flow through the chuck coils in one direction, and reversing to the other end changes the current flow to the opposite direction, thus changing the polarity of each pole in the chuck. This cannot be accomplished instantaneously, and it is plain that there must be one point in its progression at which there will be no polarity and consequently no magnetism. If the switch is opened from the second contact at this precise instant, both the chuck and work being held will be found to be completely free from magnetism. Of course in practice one could not hope to perform this operation accurately enough to demagnetize the chuck perfectly each time, but a sufficient reduction in holding power for the easy removal of work can always be accomplished.

Objection to magnetic chucks for milling and planing is often raised by inexperienced people, on account of the chips sticking to the chuck, work and tools. This is largely fallacious, as a moment's consideration would show. Each individual chip in a magnetic current becomes a separate bar magnet, having a polarity the same as the main current. It can stand only lengthwise with the current, and is only attractive to the ends of opposite polarity of its lengthwise standing neighbors. For this reason, chips will always be found standing on end on the chuck, work and tools, except where they cross a polar gap directly. In this position, they are less likely to crowd between the cutter and the work than if lying free, and as their actual attraction to the magnet is very slight, it is scarcely a factor. When the chuck is demagnetized, the chips can be removed more easily than from the average clamping fixture, as there are no clamps, straps, screws nor dogs for them to gather under; and if cast iron is being worked, the workman will appreciate the fact that the dust is all sticking to the chuck where he can carefully remove it with an oily cloth, instead of filling the surrounding atmosphere, his nostrils, lungs and clothes. On tool work that must be closely watched, if the cut is very heavy the accumulation of chips on the cutter may be somewhat of a nuisance, and it will be necessary to remove them from time to time with a bristle brush. Again, where oil is used in working steel, it is often impossible to get good results without brushing off the chips as they are formed. However, it is doubtful if these difficulties are increased to any extent by the magnetism, and the fact that it does not cure them is not a good argument against the magnetic chuck.

It is to be regretted that an alternating current will not operate a magnetic chuck satisfactorily, as this requires a special direct-current dynamo to be driven from the line-shaft in those factories equipped with alternating-current lighting systems. It is often the case, though, that the dynamo can be purchased and installed and the chuck built at less expense than would be necessary in making one clamping fixture for the work in hand. If there are a number of chucks to be supplied with current, the dynamo expense becomes but an item, and the possibility of using a much lower voltage than that supplied for lighting is at times a decided advantage, especially when rotary chucks are to be used. The life of a magnetic chuck is very long, as there are no working parts to wear or become deranged. The active face can be refinished at times to keep it true, and beyond this nothing is needed except possibly a new piece of lamp cord when the old one becomes badly frayed. Magnetic chucks are cheaper to design, build, operate and maintain than most fixtures of any other kind; and though it is true that they cannot be used in a great many cases, still there are so many kinds of work that could be successfully held by them that they are bound to become vastly more popular as their many merits are realized.

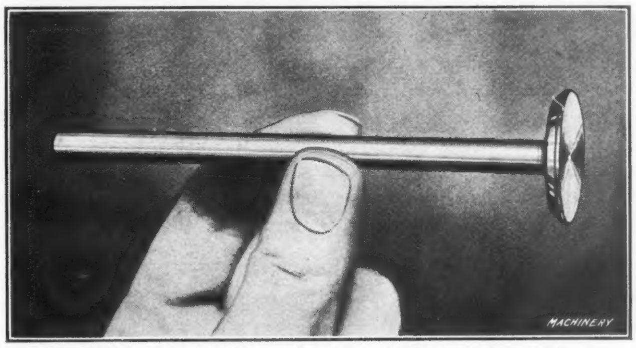
* * *

One of the most dangerous common objects and one frequently seen is a board lying on the floor or ground with nails projecting upward. Many serious accidents have resulted from such obstructions. Workmen stepping on sharp-pointed nails run the risk of puncturing their feet. A wound caused by dirty, rusty nails may cause lockjaw and death.

RAPID WORK ON THE CLEVELAND AUTOMATIC

The illustration shows a gas engine poppet valve 4 1/4 inches long over-all, having a head diameter of 1 1/16 inch, which was made on one of the Cleveland Automatic Machine Co.'s 7/8-inch machines, built for the Fairbanks-Morse Co., of Beloit, Wis., at the rate of 24 an hour, or 2 1/2 minutes each. The forming is a separate operation from the milling of the stem, because two tools cannot work in conjunction with each other on this part.

The valve stem was reduced with a single box-tool equipped with roller supports in one cut. The size of the stock is 1 1/16 inch and the diameter of the stem ¼ inch. This means that



Gas Engine Poppet Valve produced at the Rate of Twenty-four an Hour on the Cleveland Automatic

the diameter of the stem part is reduced 13/16 inch in one cut. Notwithstanding this great reduction of the diameter the stem is parallel within 0.00025 inch.

This job indicates that the Cleveland roller-rest box-tools are of first-class design, because in removing so much stock in one cut and reducing the stem to such a small diameter it is done with such close approach to exact parallelism. To be able to produce machine parts so accurately and rapidly is indeed a triumph for the automatic machine.

* * *

At the last annual meeting of the Association of German Machine Tool Manufacturers, it was stated that the reaction in the general machine building field, which manifested itself toward the end of last year, had also made itself felt in the machine tool business. The works of the various machine tool builders, however, continue to be fairly busy, although in some branches the business on hand is not sufficient. This is especially true of the works where medium and small machines for general purposes are manufactured, as the demand for this class of machinery has materially diminished. As far as large and special machine tools are concerned, the position is quite favorable, although several works, which as a rule could promise delivery only after several months, are now able to fill orders at short notice. A point of great importance to the makers of large and special machine tools in Germany is that the comprehensive extension to the works of many large concerns, and the extraordinary demands for the equipment required by the railway shops during the last few years, have now come to an end. In the same way, many works manufacturing arms have been equipped during the last few years and new equipment in this line is not required at the present time. Export business has also suffered somewhat, except the export trade to Russia, where, owing to the increased industrial activity which at present manifests itself in that country, the trade conditions are favorable.

It was stated that wages and salaries are on the increase in the machine building trades and that the ever-increasing tax burdens tend to make the cost of production greater. The competition from America and lately from England has also made itself felt in the international market. The discharge of labor has, on the whole, been avoided by the German machine tool builders, but if the trade conditions are not altered within the near future, it will be necessary to somewhat reduce the number of men in the industry. On the whole, the prospects for the present year were considered rather gloomy. It will thus be seen that the present depression in the machine tool trade in the United States is by no means a local condition.

JIGS FOR MACHINING PISTONS

BY I. W. SPRINK*

The jig shown in Fig. 1 is used successfully in cross-drilling pistons. It possesses a few novel features that may be of interest to readers of MACHINERY who have work of a similar nature to perform. In the first place it will be seen that the piston is drilled from both sides and not all the way through from one side, which is the common practice, especially when the work is done on some style of lathe. It is not an easy matter to drill and ream a true hole by starting on one side of the piston, drilling through one boss and then advancing the tool across the opening between the bosses and expecting the tool to get a true start in the second boss.

This jig was made in the following manner to insure accuracy. A block of cast iron was milled square and the large hole rough-bored to within 1/16 inch of size. This block was then milled across one end to receive the stop-bar *A*. After fitting the stop-bar, it was removed and the seat for the clamp-bar *B* was bored by using a fly-cutter in the milling machine. This clamp-bar was a piece of two-inch cold-rolled stock, milled flat to form a little more than a half round. During the succeeding boring and grinding operations the clamp-bar was held to its seat by the two screws *C* which had washers under their heads instead of the springs shown in the illustration. A piece of 0.005-inch stock was placed between the clamp-bar and seat while boring and grinding; this shim was taken out later to allow for a little clearance. After the clamp-bar was fitted and bored, the holes for the hardened bushings *D* were bored and the bushings fitted. These bushings were long enough to reach through the large bore so that they could be ground flush with the inside of the jig.

The jig was next set up on the table of a Heald cylinder grinder and the holes in the bushings ground in line and true to size. The jig was then placed on one side with the bushings in a horizontal plane and the large hole finished to size by grinding. To be sure that the holes in the bushings would be perfectly central with the large bore, an arbor was ground to a snug fit for the bushings and the large hole was gaged from it, measuring from the wall of the large hole to the arbor until both sides were exactly the same. The hole

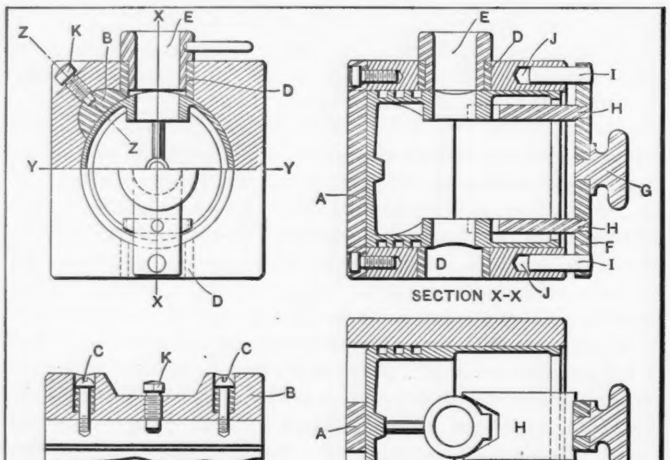


Fig. 1. Jig used for cross-drilling Pistons

was then finished 0.003 inch larger than the piston to be worked on. Two slip bushings *E* were made to fit the bushings in the jig, one for the three-lipped drill and the other for the reamer. The reamer used was 0.0015 inch under size, so that the holes could be finished with a long hand reamer that reached through both holes of the piston.

To locate the piston in the jig so that the bosses would line up with the holes being drilled, the "locater" shown at the open end of the piston was made and used in the following manner. The locater consists of the cross-bar *F*, into which are fitted the knob *G* that is used for a handle, two flat bars *H* with V-slots in the ends, and the two pilot pins *I*. The pilot pins fit into holes *J*, bored in the face of the jig in line with the bushings. In using this locater the piston was first put into the jig and then the locater was pushed in until the V-slots came in contact with the bosses. This put the piston in such a position that the bosses were in line with the drill bushings. After locating, the piston was gripped by the clamp-bar by tightening the set-screw *K*.

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In this case the pistons were rough-drilled 3/32 inch under size before turning, so that in this jig it was only necessary to use one drill and reamer. The drilling operations were as follows: The drill bushing was put in and the drill run through one side. The bushing was then taken out, the jig turned over, and the bushing put in the other side, after

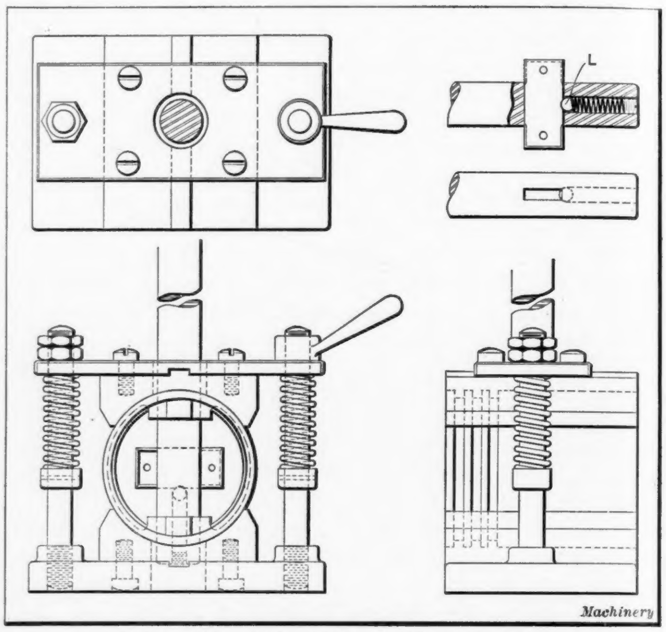


Fig. 2. Jig used for facing the Bosses in Pistons

which the second boss was drilled. The drill bushing was now replaced by the reamer bushing and the hole reamed; the bushing was then taken out, the jig turned over, the bushing replaced and the second hole reamed. It may be well to mention that when using this jig two strips were fastened to the drill press table forming a channel in which the jig could slide and which would also hold the jig in line with the machine spindle.

Jig for Facing Bosses in Pistons

Fig. 2 shows the jig and facing bar used for facing the bosses in the piston after it leaves the cross-drilling jig. It was found advantageous to do this operation in a separate jig because it consisted of top and bottom facing and also because the machine spindle had to be set to a stop. This jig proved to be a very handy and rapid tool. The base and the adjustable top are provided with a pair of jaws bored to the proper size to fit the piston to be worked on. The springs on the upright studs hold the upper or clamping jaw up while the work is being put in or taken out.

In operation, a piston is slipped between the jaws, the facing bar run down through the cross-drilled holes, the cutter fitted into the bar, and the top jaw set by a half turn of the lever handled nut. A novel feature of the facing bar is the manner in which the cutter is held. It will be seen that the cutter has a half round notch in the center of the bottom edge that registers with a steel ball *L* in the center of the cutter slot. A stiff spring holds the ball to its seat in the bar. The cutter is also provided with two holes near each end that are used for pulling it out of the bar with a stout wire hook. It is double edged, so that both bosses can be faced without reversing it or stopping the machine. This method of holding the cutter would not do in the case of a boring tool but for a facing tool it serves very well. Of course the cutter must be a nice fit in the bar. The illustrations are so plain that a detailed description is hardly necessary except to mention that when the facing jig is used it can be clamped to the machine table, while the cross-drilling jig is not clamped, because it is necessary to turn it over and over.

MACHINING AUTOMOBILE WHEEL HUBS ON BARDONS & OLIVER TURRET LATHE

Fig. 1 shows an automobile wheel hub that is made from a malleable casting and is machined in a Bardons & Oliver turret lathe in the plant of the Kelsey Wheel Co., Detroit, Mich. The method of handling this work and the sequence of operations performed upon it are interesting, and no doubt will be appreciated by mechanics in general. Fig. 2 shows the machine used, which is a No. 9 Bardons & Oliver turret lathe, and gives a good idea of the tool set-up. Figs. 3 and 4 show diagrams of the tool equipment used for performing the first and second series of operations.

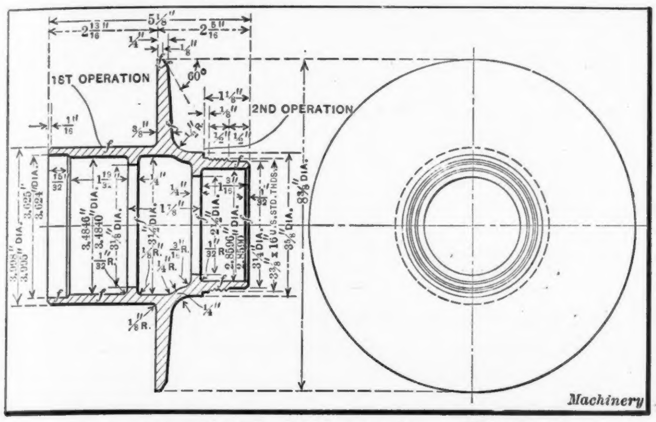


Fig. 1. Automobile Wheel Hub made from a Malleable Iron Casting and machined Complete in 7½ Minutes

The first series of operations is shown in the plan view Fig. 3. The casting *A* is held in a three-jawed chuck *B*. First tool No. 1 equipped with two cutters rough-faces the flange, while the inner and outer surfaces of the cylindrical part are rough-bored and turned by the combination turning and boring tool No. 2. This tool has, in addition to a regular bar, a bracket or tool-holder projecting above the work and carrying cutters that operate on the top or outer surface of the work. Tools Nos. 3 and 4 come into action next, tool No. 3 finishing the surfaces roughed out by tool No. 2, and tool No. 4 finish-facing the flange and end of the hub. The detailed side view of tool No. 3, which is practically the same as No. 2, shows the arrangement of the cutters *C* and *D*. One of the cutters turns the cylindrical surface of the body of the hub and the other bevels the end of the hub. The hole in the hub is next finished by tool No. 5, which is a stepped reamer that machines the bore and counterbores to the required size within close limits. The surfaces machined by the different tools referred to are indicated by the sectional view *E* of the hub, that shows which tools are used on each surface.

For the second series of operations the position of the automobile hub is reversed; in this case it is held in a spring collet, as shown in the plan view Fig. 4. The finished cylindrical end of the hub is inserted in the split collet *F* which is drawn back into the tapered collet ring by rod *G* operated by the turnstile handle *H*, Fig. 2. This closes the collet tightly around the casting. The first operation is that of facing the side of the flange and end of the hub with tool No. 6, which is held on the cross-slide in the working position shown in the illustration Fig. 4. A broad cutter *H* is used for facing the flange and finishing the large fillet, and the end is faced by a smaller cutter *I*. When these tools have been withdrawn, tool No. 7 is moved up to take the roughing cut from the outside of the cylindrical end (preparatory to cutting a thread) and rough-bore the hole. These same surfaces are then finished by tool No. 8. The arrangement of tools Nos. 7 and 8 is shown by the detailed view. Tool *J* turns the part to be threaded, while tool *K* turns the end beyond the threaded part, and tool *L* bevels the corner or edge.

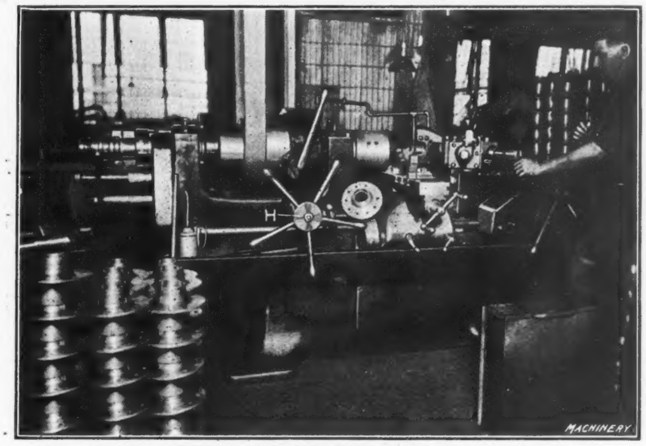


Fig. 2. No. 9 Bardons & Oliver Turret Lathe used for machining Automobile Wheel Hubs

The reaming tool No. 9 is then indexed to the working position for finishing the hole and beveling the outer edge slightly. At the same time the form tool No. 10, held on the rear of the cross-slide, is brought up for beveling the flange to an angle of 60 degrees and turning the outside of the flange

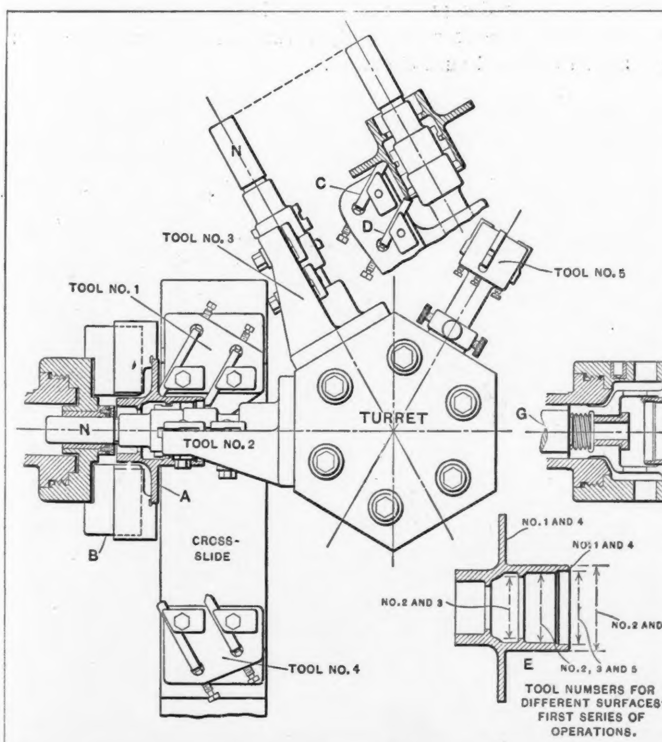


Fig. 3. Diagram showing Layout of Tools for performing First Series of Operations on Automobile Wheel Hubs

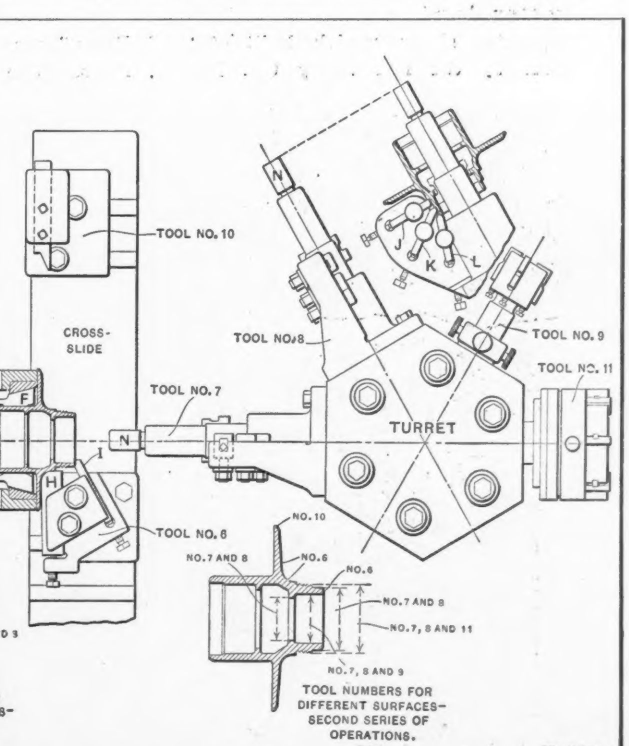


Fig. 4. Diagram of Layout of Tools for performing Second Series of Operations on Automobile Wheel Hubs

to size. The final operation to be accomplished is that of threading the end, which is done with die No. 11. The boring-bars of tools Nos. 2, 3, 7 and 8 are all provided with pilots *N* which enter close fitting bushings held in the spindle to steady the bar while the cuts are being taken—this is a common method of supporting the tools.

The feed of the turret for both the first and second series of operations is 1/27 inch per revolution of the work, and the work is rotated at 60 revolutions per minute for taking the roughing cuts, and 90 revolutions per minute for taking the finishing cuts. The total calculated time for machining one of these castings is about 7½ minutes, which includes the time required for placing the work in the chuck, but a product of 85 to 95 completed hubs is secured in ten hours. The following gives in detail the actual time required for each operation and indicates the ease and rapidity with which this work is handled.

Time for first series of operations on hub: chucking, holding work in a three-jawed chuck—20 seconds;

Tools Nos. 1 and 2: rough-facing, turning and boring, 1 minute, 45 seconds;

Tools Nos. 3 and 4: finish-facing, turning and boring, 1 minute;

Tool No. 5: finish-reaming, 37 seconds;

Total time for first operation, 3 minutes, 42 seconds.

Time for second series of operations: chucking, 10 seconds;

Tool No. 6: facing, 45 seconds;

Tool No. 7: rough-turning thread end and rough-boring, 1 minute, 3 seconds;

Tool No. 8: finish-turning thread end and finish-boring, 37 seconds;

Tools Nos. 9 and 10: finish-reaming and forming, 45 seconds;

Tool No. 11; threading, 25 seconds;

Total time for second series of operations, 3 minutes, 45 seconds.

D. T. H.

* * *

TOY CONSTRUCTIONS FOR ENGINEERS

Two or three concerns have lately placed on sale construction materials for boys, amateurs and others interested in the making of models, etc. These devices were first offered as toys pure and simple, but later developments apparently have shown their value for engineers, inventors and others desiring to make working models of bridges, towers, frames, cranes, etc. Models can be quickly and cheaply made to illustrate constructions much more graphically than drawings.

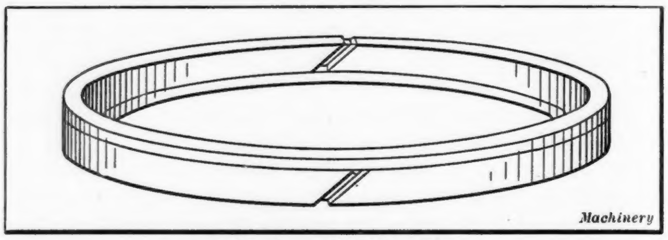
The illustration shows models built of "Bill Deezy" materials, made by the Bill Deezy Co., Boston, Mass. The basic principle of this construction is very simple, consisting of so-called flexible joints and coppered steel constructive rods. The flexible joints are in the form of a tinned sheet metal cross. The arms of the cross are curled, forming four sockets for the construction rods. These joints can be used in a variety of ways. When only three wires are to be joined, the fourth arm is removed with pliers. If only two arms at an angle are required, the other two are removed, etc. The material is sufficiently flexible to allow the arms to be bent to other angles than 90 degrees. Bracing wire, pulleys, car wheels, cable, are also supplied for working models of crane mechanism, etc.

Contractors should often find these construction materials useful when figuring on estimates of work out of the ordinary. Models on a small scale can be made and a better idea of the constructive difficulties can be obtained in many cases, no doubt, than where everything is laid out on paper.

* * *

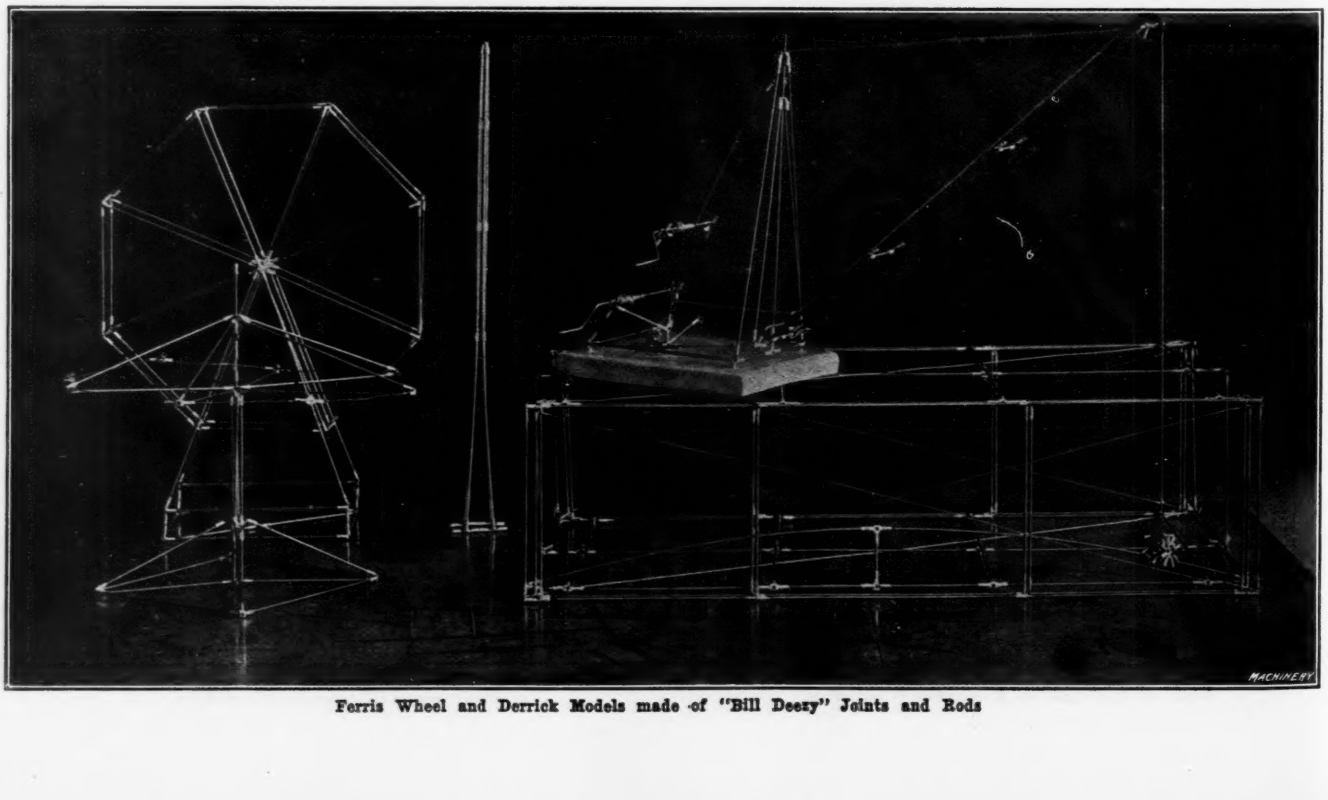
"LEAK-PROOF" PISTON RING

It is a curious fact that the common piston rings of steam and gas engine pistons are makeshift contrivances for which no greatly superior substitutes have been invented. Probably none of the piston rings in use are leak-proof except when the cylinder, piston and rings are newly fitted. As soon as



A "Leak-proof" Piston Ring

wear takes place the steam and gases can escape through the opening in the rings past the piston. Different forms of piston rings have been devised to overcome the fault, but none have been completely successful. They have succeeded in fooling users perhaps, but not the fluids that they were intended to restrain. The illustration shows a double piston ring designed for gas engines that is advertised as "leak-proof." It is a double ring consisting of two concentric angle rings split in the usual manner and fitted together so that the openings in the rings are opposite. No doubt this is an efficient design, but obviously it cannot be leak-proof when the cylinder and piston grooves are worn. When the gases can freely enter the groove beneath the rings from the pressure chamber, they escape readily through the opening in the ring next to the exhaust chamber.



Ferris Wheel and Derrick Models made of "Bill Deezy" Joints and Rods

RECESSING TOOLS*

TOOLS, ARRANGEMENTS AND FIXTURES USED FOR RECESSING IN LATHES AND BORING MILLS

BY ALBERT A. DOWD†

MANY varieties of cylindrical work call for the machining of an annular recess or groove in a place which may be inaccessible to the cutting tools. The form of recess varies greatly and the accuracy required is likewise variable. The form may be either narrow or wide, deep or shallow, while the accuracy called for may be either within narrow or liberal limits, as, for instance, when the recess is for clearance only. In fact, in the majority of cases the purpose of the relief or recess is merely to obtain clearance for some moving part or for tools when machining an adjacent surface. Very frequently a groove is cut to serve as an oil-pocket or to provide a space which can be filled with packing to act as a gland. It is evident that great accuracy is not essential when the work is of this nature. There are occasionally conditions which require more accurate work, as, for instance, when another piece is to be sprung into place, such as a spring ring or something of a similar nature, but even in a case of this kind a certain amount of inaccuracy is permissible. The machines to which recessing tools are most frequently fitted are the engine lathe, the horizontal turret lathe, the vertical turret lathe, the vertical drilling machine and the horizontal boring mill. Other machines are occasionally equipped with tools for the same purpose, but those mentioned are most frequently used.

In many cases the position of the relief or groove is such that it cannot be readily seen by the operator, nor can it be easily calipered. The workman, therefore, must tell how the tool is cutting by the "feeling" of it and by the character of the chips. He is really "working in the dark," and for that very reason every precaution must be taken, in regard to position of tools, diameter and shoulder stops, etc., so that the machining can be done without withdrawing the tool to note the progress of the work. In this connection it is well to bear in mind that the action of any kind of grooving tool is much the same as a cutting-off tool. It must be kept very sharp and set so that the cutting edge is slightly above center, when it is used for internal work. It will be seen that if the tool is slightly above center the springing down of the cutting edge (due to the pressure of the cut) will have a tendency to keep it from "digging in," and will therefore assist in the prevention of chatter. Some of the important points in the design of recessing tools are given herewith.

* For previous articles on this and kindred subjects, see MACHINERY, March, 1914, "Design and Construction of Boring Tools"; February, 1914, "Adjustable and Multi-cutting Turning Tools."

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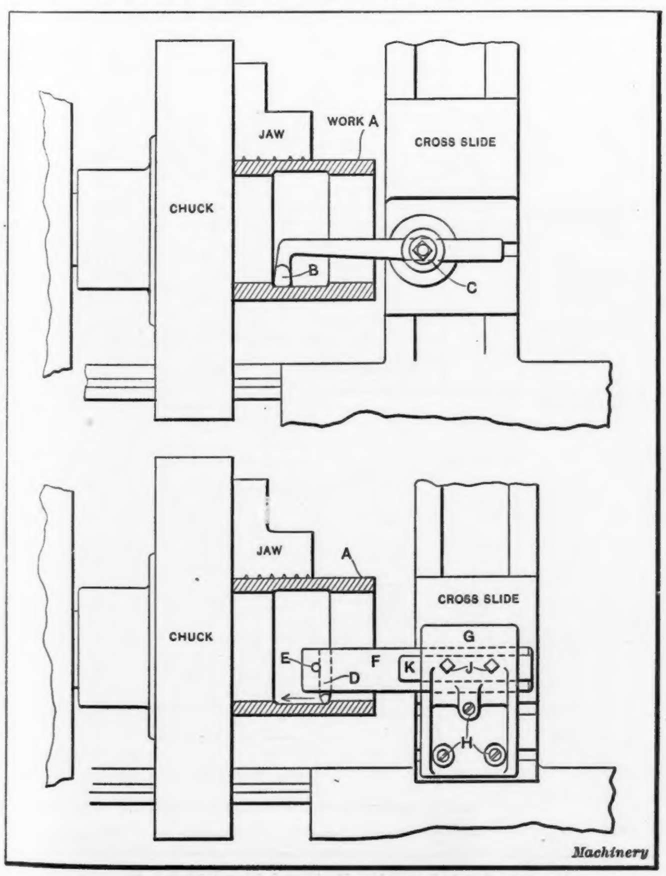


Fig. 1. Two Simple Types of Recessing Tools for the Engine Lathe

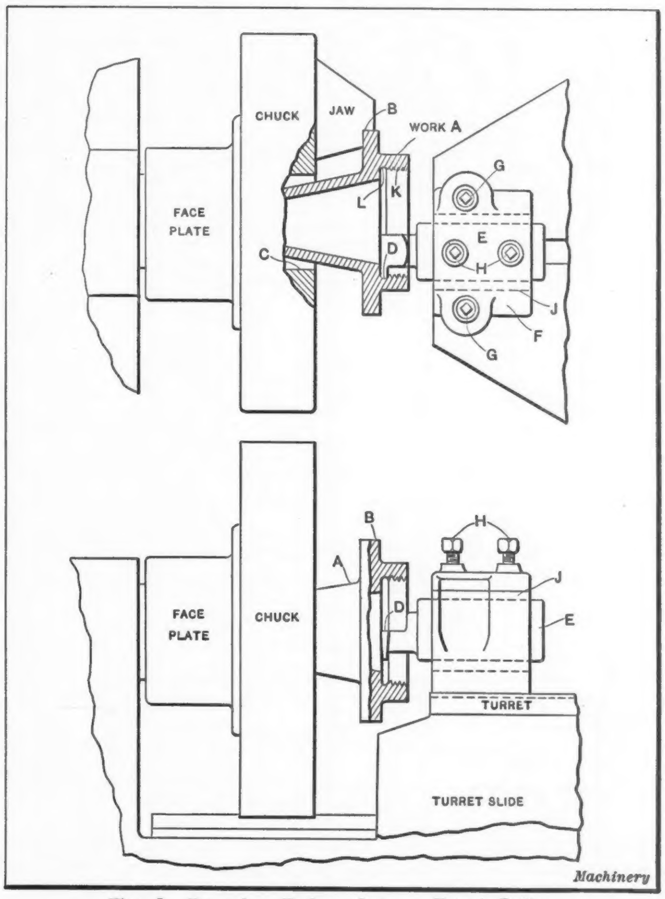


Fig. 2. Recessing Tool used in a Turret Lathe

Points in Design of Recessing Tools

1. Rigidity is of the greatest importance and every precaution should be taken to insure as substantial a holder as possible. The tool itself should be of as great a section as the conditions and the space will permit. Some method of supporting the overhanging end should be provided, either by means of a pilot or in some other way which may suggest itself. Moving parts should have a means of adjustment for wear, and gibs should be set up as snugly as possible and still allow free movement.

2. The feed motion should be carefully considered. Screw feed is best, and may be contained in the tool itself or may be operated by the cut-off slide. Lever feed is uncertain and produces uneven cutting unless the work upon which it is used runs at high speed. When this is the case and if the cut is not too heavy, it can be used with satisfactory results. The work to be done is a factor in determining the method most satisfactory for the feed motion.

3. Means are needed for determining the depth of the cut. There are several ways in which the depth of the cut can be positively determined: a positive stop can be provided; the dial on the cut-off slide can be used when the feed motion of the slide is the operating force; an indicator or a graduated dial on the tool-holder itself may be provided.

4. Rapidity of operation is essential.

5. Adjustment for the cutting tool should be provided.

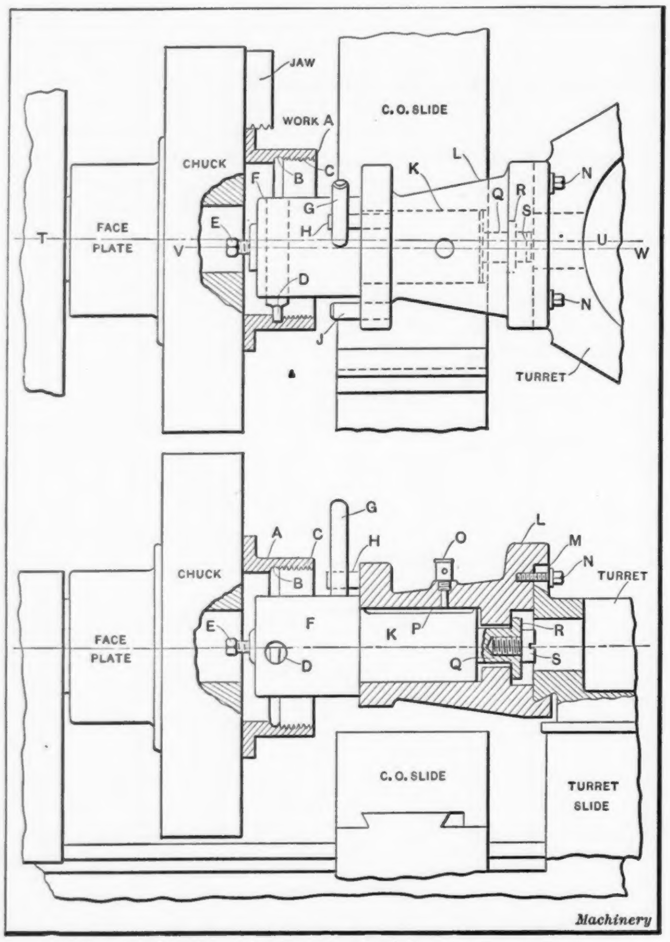


Fig. 3. An Eccentric Recessing Tool for the Turret Lathe

This adjustment may be made either by manipulating the tool by hand or by means of a backing-up screw. The latter method is the better one and should be used whenever practicable. The upkeep of the tool is important, and for that reason inserted tools are preferable to those which form a part of the mechanism itself. In confined situations it is occasionally necessary to make the tool of special shape. This should be done only as a last resort, when necessitated by the conditions governing the work. In cases of this kind several tools should be made to provide for emergencies.

Recessing Tools for the Engine Lathe

The upper illustration in Fig. 1 shows a bushing *A* which is held by the outside in regular chuck jaws. This work is to be done on the engine lathe, and the recess is to be cut at the same setting. A forged tool *B* is held in the regular toolpost *C* on the cross-slide of the lathe, and is forced into the required depth by hand. After this the longitudinal feed is started and the remainder of the recess cut. This type of tool is much used for lathe work when only one or two pieces are to be machined. Its advantages are that it can be easily made and quickly adjusted. Its disadvantage is that it has a tendency to chatter, and is, therefore, suitable only for very light cutting.

The device shown in the lower portion of the same illustration is much more rigid, but is not nearly so adaptable to various conditions. In this arrangement, the tool *D* is of round section and is held in place by taper pin *E*. The bar *F* is of steel and is secured in the holder *G* by the two screws *J* which bear against a flat *K* on the bar. Three screws *H* enter shoes in the cross-slide T-slots and secure the holder firmly to the slide.

Recessing Tool for a Horizontal Turret Lathe

The work *A* shown in Fig. 2 is a steel forging of an automobile hub which is held in a three-jawed chuck by the flange *B*, the tapered portion entering the hole *C* in the chuck body. The inside of the hub is to be threaded at *K* with a collapsing tap. A recess is therefore needed at *L* in order to obtain a clean thread. The machine selected for the work is a Pratt & Whitney turret lathe having a cross-sliding turret of the flat type. The recessing tool is of high-speed steel, with the shank turned and ground cylindrical at *E*. The front end is also turned to form the flange *D*, and is afterward cut away and finished to the shape required, as clearly shown in the lower part of the illustration. The tool-holder *F* is of cast iron and contains a steel split bushing *J* which is compressed by two screws *H* in the top of the holder. The action of this tool was satisfactory, but the upkeep is obviously rather expensive.

Eccentric Recessing Tool for a Horizontal Turret Lathe

The work *A* shown in Fig. 3 is a steel flange which is to be recessed at *B* in order to provide the necessary clearance for the threaded portion *C*. In this instance the cut-off slide was used during the progress of the work, so that a considerable overhang from the turret was required. Strictly speaking, this is not an eccentric tool, for the various parts of the body are concentric, but by a reference to the upper part of the illustration it will be seen that the center-line *VW* of the recessing tool does not coincide with the center-line *TU* of the spindle. Now as the tool-holder *F* revolves on the center-line *VW*, it is evident that the path of the tool *D*, as it swings, will be eccentric to the center-line of the spindle. The body *L* is of cast iron and is mounted on the dovetailed turret face, being securely held in position by the gib *M* and the screws *N*. The tool-holder *F* is of tool steel and is turned down at *K* to a running fit in the body. The end *Q*, with the screw and washer *S* and *R*, acts as a retainer to keep the tool-holder in position. The tool *D* is of round section with the cutting end so shaped that it will cut the recess properly. A set-screw *E* holds it in position. An oiler *O* is located in the body and distributes the oil to the bearing through the oil groove *P*. An operating handle *G* is driven into the holder, and is located between the pins *H* and *J* which act as stops. As the lever *G* is operated, the tool *D*, starting with slight clearance at the bottom of the hole, moves gradually upward and outward until the full depth of cut has been reached. At the completion of the cut the tool stands in the position shown in the illustration. The action of this tool was perfectly satisfactory, and as it is comparatively simple in construction, the cost of building was not excessive.

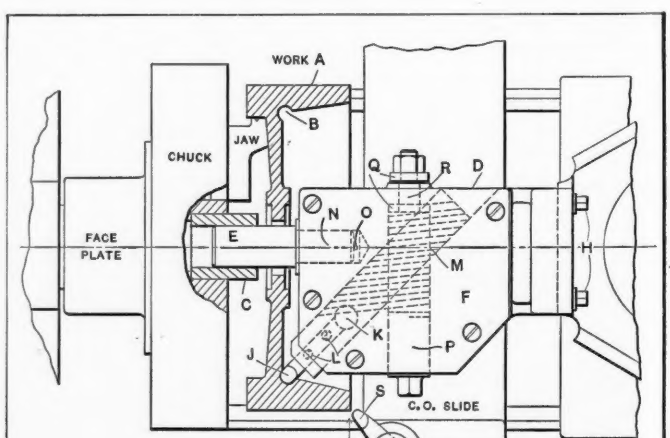


Fig. 4. A Recessing Tool used in machining an Automobile Flywheel

Piloted Recessing Tool for an Automobile Flywheel

A rather peculiar condition is shown in Fig. 4, the work *A* being an automobile flywheel having a semicircular recess at *B*. Attention is called to the fact that this recess is put in at an angle of 45 degrees with the center-line. It is evidently only a clearance groove for the male clutch member, and it is not known to the writer why some other style of groove would not have answered the purpose just as well.

The work *A* is held by the inside of the rim in special jaws. The body of tool *D* is made of cast steel and is fitted to the dovetailed face of the turret, the gib *G* securing it firmly by means of the collar-head screws *H*. A tool-steel pilot *E* enters the bushing *C* in the chuck and assists in supporting the body against the pressure of the cut. This pilot *E* is shouldered and forced into the body at *N*. A small hole *O* is drilled to avoid air compression when forcing in the pilot. If this is not done the fitter may be deceived into thinking that he has secured a good fit at this point when in reality it is the air compression which causes the stem to fit tightly. A cover plate *F* tends to strengthen the body and overcome the weakening effect caused by the cutting of the angular slot, and also assists in preventing the entrance of dirt and chips. Tool *J* is of square section and is held in the sliding block *M* by two screws *L*. Hole *K* is for machining purposes only. The operating screw *P* is squared up on one end to receive a wrench, while the other end is shouldered at *R* and threaded to receive a hexagon nut. There are two thrust washers shown at *Q*. The screw has four Acme threads per inch, right-hand, and meshes with the angular rack cut on the under side of the tool-carrying slide *M*. It is evident that the rotary motion of screw *P* will cause movement of the block, in its longitudinal direction, thus feeding the tool into the work at the desired angle. The forged tool *S*, held in the tool-holder *T* on the cut-off slide, is slowly fed across the rim while the recessing operation is taking place.

Double Recessing Bar for a Rear Axle Housing

The work *A* shown in Fig. 5 is a bronze rear axle housing for an automobile, and the recessing bar is only one of a group of tools used at the same setting of the work. Previous to this setting the finished annular rings at the two ends *D* and *E* of the casting were machined so that they might be used as locating points in this setting. The ring *D* slips into the split bushing in the holding device *B*. The other end *E* revolves in a roller back-rest *F* which is placed on the ways of the turret lathe. This back-rest is not shown in detail, as its construction is not essential in connection with the recessing tool. The two grooves in the work at *S* were to be spaced an exact distance apart and it was partly to insure accurate spacing that this bar was designed, although rapidity of operation was also a factor. A cast-iron bracket *K* is fastened to the dovetailed face of the turret by means of gib *Y*, shown in the lower view. The handwheel *W* is connected to a shaft which drives the pinion *M*. A steel pointer *X* is fastened to the bracket and acts as an indicator on the graduated rim of the wheel. It will be seen that this arrangement makes it very easy to determine the depth of the cut.

Fig. 5. A Double Recessing Tool Arrangement for a Rear Axle Housing

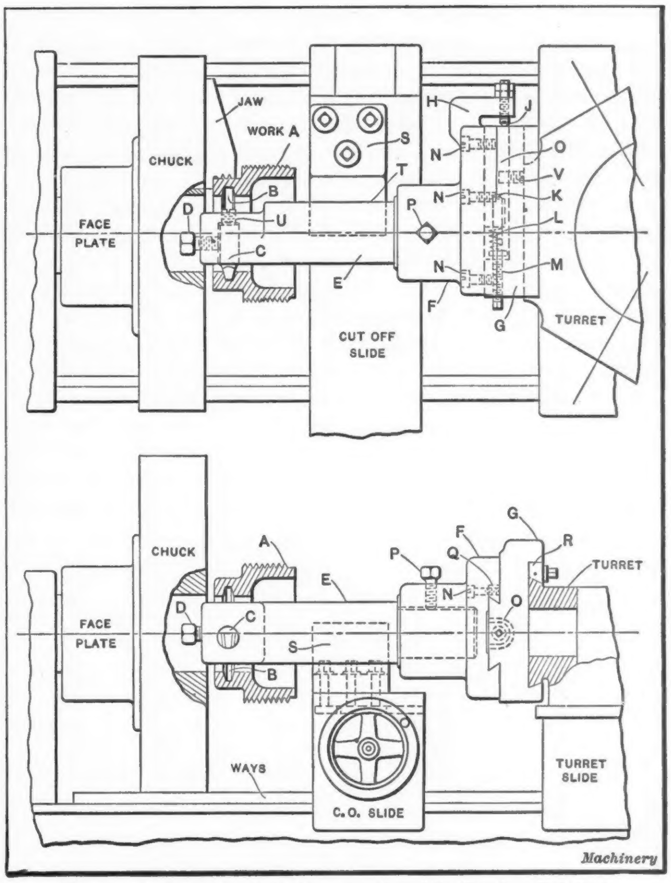


Fig. 6. A Recessing Tool for an Automobile Bearing Retainer

The pinion *M* meshes with a rack cut upon the enlarged end *N* of the operating rod *L*. This rod is considerably below the center of the bar and is flatted at *O* and *P*. The tongues *Q* and *R* are angularly cut on these surfaces, and they engage with grooves on the under side of the tool-carrying blocks *T*, so that any longitudinal movement of the rod *L* is transformed into a radial movement of the blocks. The grooving tools *S* are of round section and are held in position by the headless screws *Z*. The backing-up screws *U* permit accurate adjustments to be made with ease. The pilot *H* enters the steel bushing *C* in the body of the holding device and assists in preventing chatter. An added refinement to this tool was an oil-groove from which oil was led directly to the cutting tools. This was supplied with oil through a special piping system and a distributing collar on the turret. In order to avoid confusion in the drawing, this has not been shown. This device gave very satisfactory results.

Recessing Tool for an Automobile Bearing Retainer

The work shown at *A* in Fig. 6 is a malleable iron bearing retainer for an automobile. The casting is held by the outside in a three-jawed chuck; the machine on which the operations are performed is a horizontal turret lathe. The piece is completely finished in one setting. As the cut-off slide front tool carrier was used during the progress of the work, it was found necessary to design the recessing tool so that it extended out over the slide. It is evident that an overhang as great as this would cause trouble unless some means of intermediate

support were provided. The bracket *S* was therefore used on the rear of the cut-off slide, the portion *T* being cut out to the radius of the bar so as to act as a support and at the same time provide the feed motion necessary (through the reverse feed of the slide) to force the tool into the work. The cutting tool *C* is of round section properly shaped at the end to form the required groove *B*. It is secured in place in the bar *E* by the set-screw *D;* radial adjustment is secured through screw *U*. The rear end of the bar is shouldered and fitted to the sliding bracket *F;* the set-screw *P* holds it in place. The slide *F* is dovetailed and is gibbed to the fixed bracket *G* by the gib *Q* which is adjusted for wear by the screws *N*. The lug *H* at the end of the slide is provided with a stop-screw *J* which permits close adjustments to be made for the depth of cut. This lug is not shown in the lower view, but it is set slightly to one side of the cored groove *O* so that the screw will bear against the solid portion. The bracket *G* is mounted on the dovetail of the turret and is held in place by the gib *R*. The special screw *M* is shouldered to receive the coil spring *L* which thrusts against it and against lug *K* on the slide. The strength of the spring may be easily adjusted by the screw to the desired compression. The screw *V* is simply used to limit the reverse movement of the slide, so that it will not move back too far before or after the work has been done. This device was used for three different pieces by simply changing the tool and regulating the stop-screw. Its performance was thoroughly satisfactory.

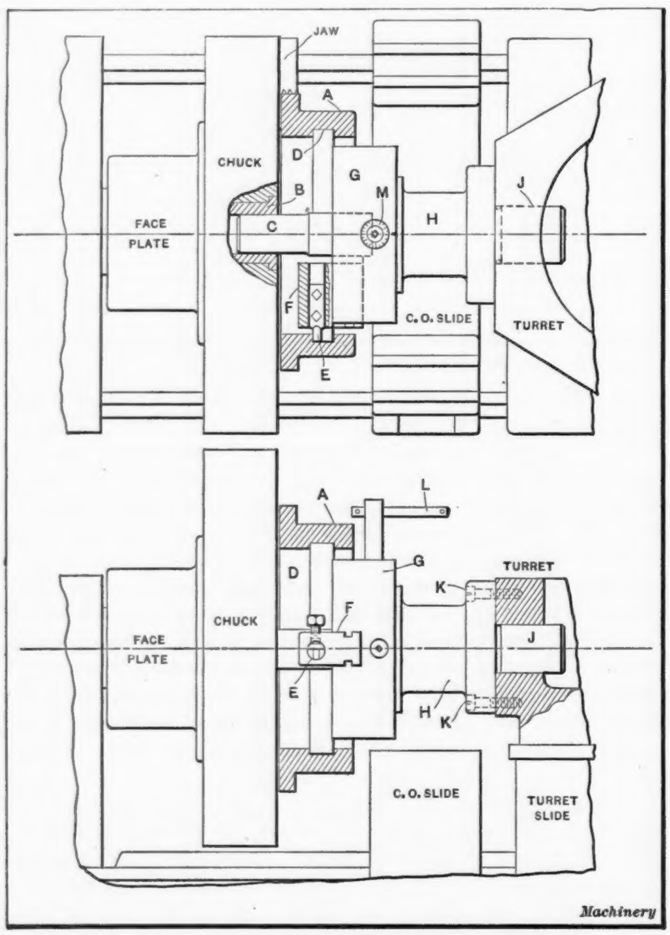


Fig. 7. A Recessing Tool for a Large Collar, used in a Turret Lathe

Recessing Tool for a Large Collar

The large collar *A* in Fig. 7 was held by the outside of the flange in a three-jawed chuck on a horizontal turret lathe. The internal groove *D* was to be cut during this setting of the work, and as a small geared scroll chuck was conveniently available, it was arranged as a recessing device for this casting. The cast-iron bracket *H* was fitted to the faceplate recess at the rear of the chuck body. The stem *J* was turned down to fit the hole in the turret face, and the four screws *K* secured it thereto. One of the standard chuck jaws *F* was annealed and shaped up as shown. It was then drilled to receive the tool *E*, and tapped out so that two set-screws could be used to hold the tool. The jaw was then rehardened and a small amount of fitting done so that it worked smoothly. A graduated collar was applied at *M*, and a special wrench *L*, having a slip handle, served to operate the scroll and thereby caused the tool to move radially as required. A tool-steel pilot *C* was forced into the center hole in the chuck body *G*, and a bushing *B* in the spindle chuck body served as a guide and support for it, thereby greatly increasing the efficiency of the tool and doing away with the chance for chatter.

Recessing Bar for a Triple Groove

In all of the examples which have so far been given, the work has been done in a horizontal plane, but we shall describe a few cases which are handled in a vertical plane on the vertical turret lathe. As this machine has a turret slide which can be traversed horizontally, it is evident that no special attachments are required for plain recessing or grooving, but there are conditions which may be decidedly out of the ordinary, under which a special arrangement for recessing may be used to advantage, for example, any sort of groove which is deep down in a hole, multiple grooving at a considerable depth, or any other condition of a similar nature. When the groove is very deep there is naturally a considerable overhang of any tool which may be used for the work. If the overhang is excessive, it follows that there is apt to be more or less vibration, and vibration means chatter. If, however, a tool or bar having an excessive overhang from the turret is supported at its lower end, the tendency to chatter is at once overcome; but, if support is provided at this point, the horizontal movement of the turret slide cannot be used. Therefore, some method which will give a radial movement to the grooving tool must be used when the bar is to be supported at its lower end.

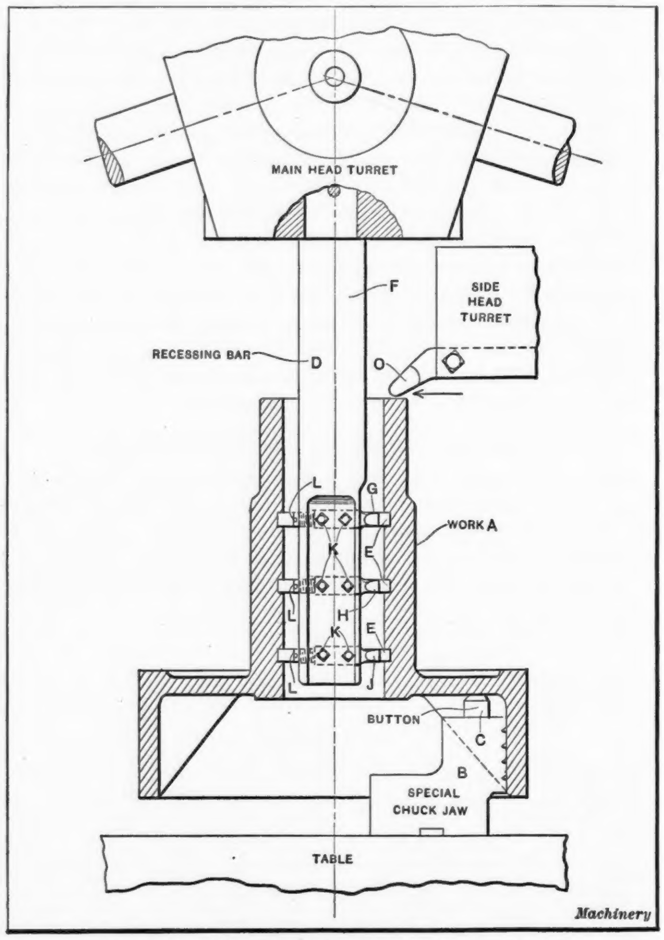


Fig. 8. A Multiple Recessing Tool used in a Vertical Turret Lathe

Fig. 8 shows a piece of work at *A* which is set up so that it can be machined complete in one setting. The casting is held by the inside of the rim in special chuck jaws *B*, and is supported at three points on the steel buttons *C* which rest in pockets in the jaws. The inner ribs of the casting act as drivers against the sides of the jaws. The three grooves *E*

are to be machined and the tools *G*, *H*, and *J* are correctly spaced to perform the work. These are secured in the bar *D* by means of the set-screws *K*, and accurate adjustment is provided by screws *L*. The bar *D* is shouldered at the turret face and is driven by a pin in the turret in the usual manner. The tool *O* in the side head turret is used for facing while the inside work is being done, as this brings the cutting action of the outside and inside tools in opposition and therefore tends to overcome vibration. If a very fine feed is used on the turret traverse, good results may be obtained with this method, although there is a tendency to chatter due to the excessive overhang. Slight variations in the depth of the grooves may also be found on account of the spring of the bar.

Piloted Recessing Bar for a Triple Internal Groove

The cast-iron valve cap shown in Fig. 9 is another example of a piece of work having three grooves equally spaced, and in which the lower groove is at a considerable distance from the turret. This piece is finished complete in one setting and is held by the outside of the flange in the standard chuck jaws *C*, being supported at three points by the buttons *D*. This tool is somewhat similar in its operation to that shown in Fig. 5, except that it is arranged in a vertical instead of in a horizontal plane. A heavy cast-iron bracket is bolted against the turret face *K* by screws *L*, and a locating plug *J* centers the device in the turret. The bar *H* is of steel and has a pilot *G* at its lower end. This pilot is hardened and ground to fit the bushing *E* which is inserted in the center of the table. The top of the bushing is milled out to leave three projecting pads *F*. These pads form a positive stop to insure the correct height; it will be noted that the tendency, when in action, would be to keep these pads clean and free from chips or dirt. The upper end of the bar is shouldered and is fastened to the bracket. As in the former instance the operating rod *Z* is flatted at certain places and angular tongues *P* are provided.

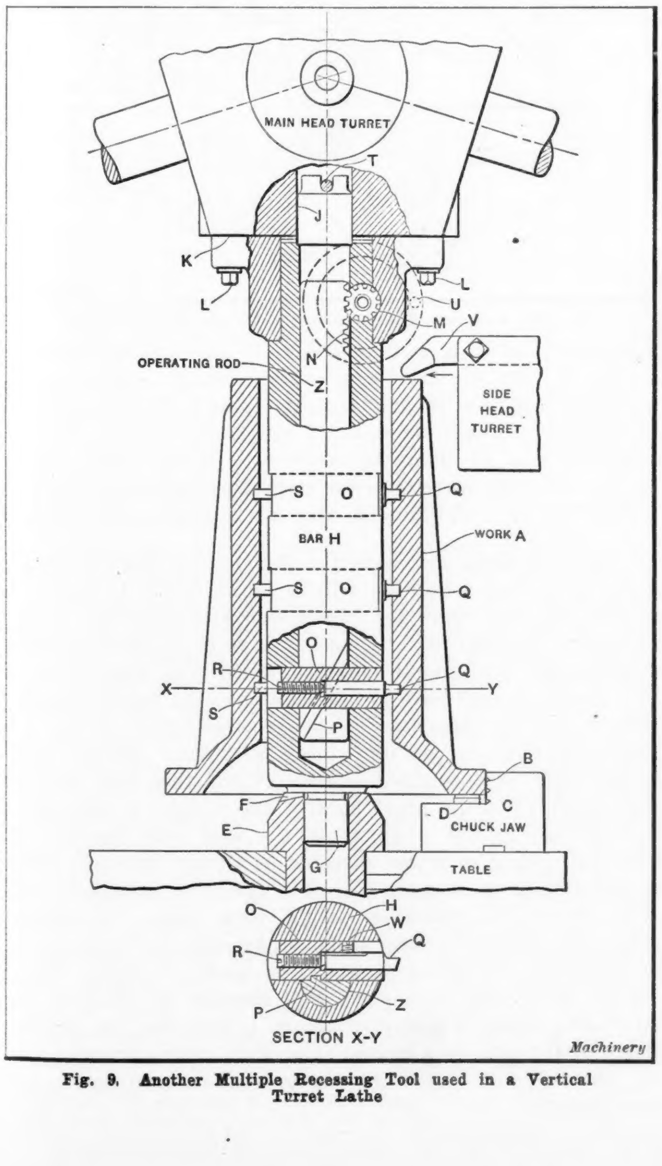


Fig. 9. Another Multiple Recessing Tool used in a Vertical Turret Lathe

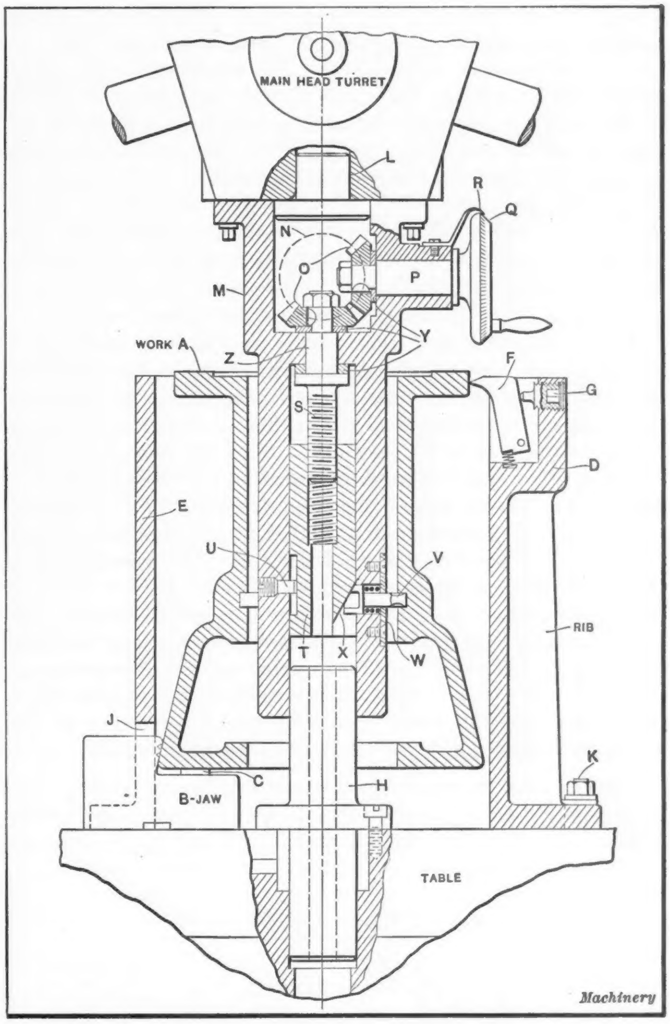


Fig. 10. A Tool for recessing in a Difficult Position, in Use in a Vertical Turret Lathe

These tongues mesh with corresponding grooves in the tool carrying blocks *O*. The section *X-Y* gives a good idea of the construction.

The tools *Q* are held in place by the short set-screws *W* in the square steel blocks *O*. The backing-up screws *R* permit of rapid and easy adjustment. At the upper end of the operating rod the rack *N* is cut and the pinion *M* meshes with it and operates the rod. The handwheel through which the pinion is operated is indicated at *U* by the dotted lines. This portion of the mechanism is identical with that described in Fig. 5. The tool *V* in the side head turret is used for facing the end of the casting during the progress of the recessing operation.

Recessing Tool Operated by Bevel Gears

A somewhat unusual condition is shown in Fig. 10, this arrangement having been suggested for the work *A* in order to rapidly perform the grooving operation deep down in the interior of the casting at *V*. It was desired to machine this casting complete at one setting. The chuck jaws *B* were of special form, having a slight angle on the inside of the jaw which drew the casting down onto the three points *C*. A cast-iron pot *E* was fastened to the table by screws *K*, and cored openings *J* were left at the points where the jaws gripped the work. Midway between the jaws, the pot casting took the form shown at *D* and the dogs *F* were sunk into the edges of the flange by means of the hollow set-screws *G*. The bar *M* is a steel casting which bolts against the turret face at its upper end; it is located by the plug *L*. The operating sleeve *T* is of tool steel, hardened and ground, and having an angular slot *X* at its lower end, which bears against the tool *V*. It is well to make up several of these tools, so that replacements can be quickly made in case of breakage. A steel plate *W* is let into the casting at this point to form a cover plate for the tool and spring pocket. A teat-screw *U* fits a slot in the operating sleeve and prevents it from turning.

The left-hand threaded shaft *S* is journaled at its upper end

Z and the miter gear *O* is keyed in place. The shaft *P* carries another gear which meshes with the former, and the entire mechanism is operated by the handwheel *Q*. (This handwheel, in reality, is located 45 degrees toward the front of the machine from the position shown). A pointer *R* assists in making accurate readings from the graduated bevel on the handwheel. Steel thrust collars *Y* are provided for wear. The tool-steel pintle *H* is fitted to the center of the table and is held down by the screws shown. This pintle acts as a guide upon which the mechanism is located and greatly assists in making it rigid.

Arrangement for External Grooving

A thin piece of work for electrical machinery, shown at *A* in Fig. 11, has been completely machined with the exception of the groove *B*. At the time when the operation of grooving takes place, a revolving steel pilot *G* fits the previously reamed hole *C* and is held in its position on *H* by the nut and washer *J* and *K*. The upper portion of the bar *F* is shouldered at *E* and fits the turret hole, being kept from turning by pin *D*. A round bar *N* is flatted on two sides at *O* and is held in the side-head turret by the three screws *R*. The lower portion of the bar carries the grooving tool *P* which is held in place by the two screws *Q*. A tool-steel pin *M* is forced into the bar *N* and forms a sliding tie between the pilot bar *F* and the side-head bar *N*. The bushing *L* is inserted in the pilot bar to receive the pin. It will be readily seen that this method overcomes the vibration which would naturally be caused by the grooving tool acting on the thin and unsupported hub.

Recessing Tool for a Dovetail

The casting shown at *A* in Fig. 12 is a portion of the clutch mechanism for a farm engine, and it was desired to machine

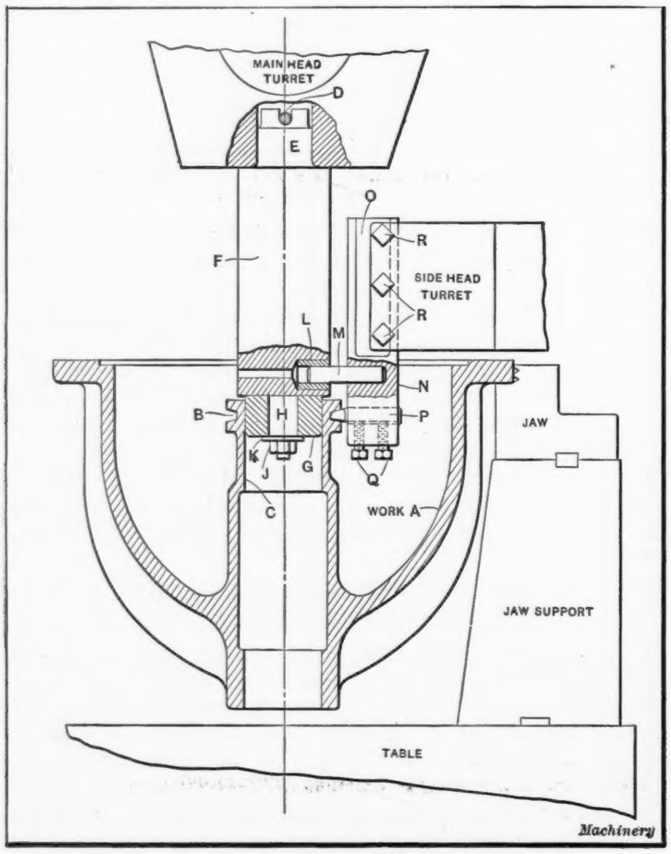


Fig. 11. An Arrangement for cutting a Groove on the Outside of a Sleeve

the piece complete in one setting. The work was, therefore, held by the inside by special jaws *B* and supported at three points by the steel buttons *C*. A good driving action was provided by the side of the jaws bearing against the ribs shown. In order to properly make the dovetail cut *D*, it was necessary to move the tool radially to secure the proper depth and then move it upward and downward in order to machine the corners of the dovetail. The shoulder in the casting made it impossible to see the work which was being done. The steel bushing *U* was centered in the table and acted as a guide for the pilot-end of bar *L*. The entire bar is a steel forging and contains a plug *V* at its lower end against which the coil spring *W* thrusts. The operating rod *N* bears against this spring which is sufficiently strong to keep it up to the limit of its upper movement. The lower portion of the rod is slabbed off at *X* to a 20-degree angle, this angular portion acting as a wedge to force the tool-block *S* outward. A flat spring *T* keeps the tool-block back against the angle on the operating rod and assists in releasing the tool after the groove has been cut. The dovetail tool *R* is held in position in the block by means of the two screws shown. The operating lever *O* is pivoted at *Y* and passes through a slot in the operating rod *N*. A pin *Q* bears against the elongated slot *P* and thereby

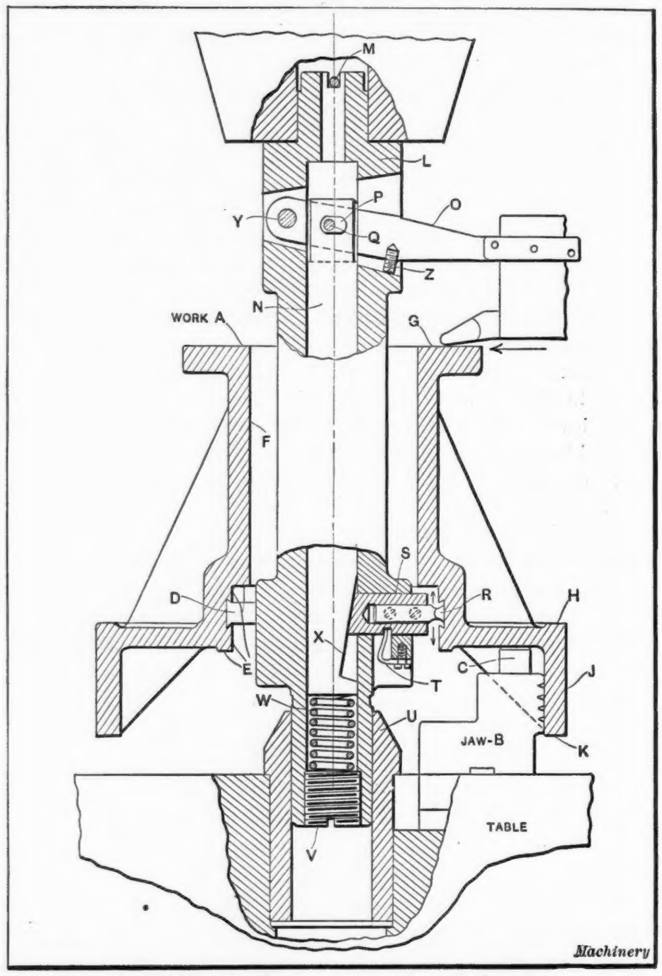


Fig. 12. A Recessing Tool cutting a Dovetail-Shaped Recess

moves the rod in a vertical direction. The adjustable stop-screws *Z* limit the movement. The lever *O* is shown in a position 45 degrees toward the rear of the machine from that in which it is really located. It will be noted that the side-head tool may be facing the work at *G* during the progress of the recessing operation. In machining this piece the surfaces *D*, *E*, *F*, *G*, *H*, *J*, and *K* were all finished at this setting.

* * *

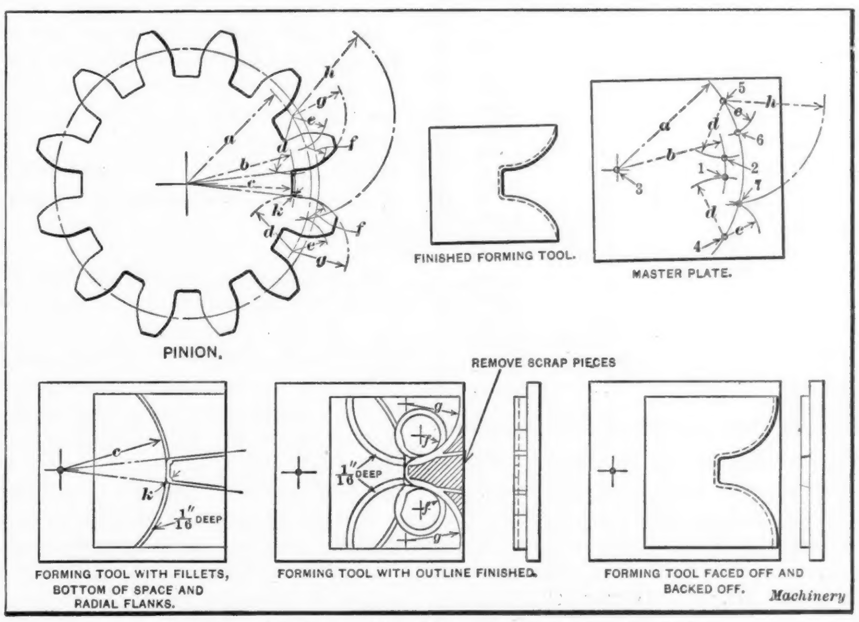
In an interesting article in the *Manchester Guardian* (England) the author asks what will be the next step in our civilization that will follow the iron age, or as some people prefer to call it, the steel age. Some day it is conceivable that the mineral and coal supplies of the world will give out, and then the world will have to fall back upon the vegetarian substances for all materials of construction, these being the only ones that can be reproduced with such rapidity that there would be a constant supply. When this time arrives, the author says, the great bulk of the world's requirements will be met by the products of the field and the hillside. Fuel will either be grown directly, as timber, or more likely be distilled from suitable plants in the form of alcohol and oils. Structural materials would then, again, be mainly stone and wood, and only tools, ornaments, and products to meet special requirements would be made of metal. When such a time comes, the world will literally go "back to the land" and evolve a new civilization, multiplying the productivity of the land to a degree at present beyond imagination. In the history of the world, the present mineral age is but one brief day.

MAKING A FORMING TOOL FOR A GEAR-CUTTER

BY EARLE BUCKINGHAM*

If the shape of the teeth in a rack or gear is known, the shape of the teeth for another gear to mesh with it may be determined by laying out a tooth of the known gear to an enlarged scale and revolving it about the pitch circle of the other gear, thus generating the shape of the required tooth. Arcs may then be found to match this generated shape. Grant's "Treatise On Gear Wheels," pages 29 and 42, gives tables for the shapes of both involute and cycloidal teeth that are close enough for the majority of gears. These tables may also be found in MACHINERY's Handbook on page 583.

There are several ways of making templets and forming tools for the gear-cutter; I wish to describe one method that is simple and accurate, and may be carried out with the tools found in every tool-room. With this method a templet is not necessary, as the forming tool is made directly; but if desired, the templet may be made in a similar manner. After the proper shape of the tooth is determined, the distances between the centers of all of the radii are computed and a master plate is made with holes accurately drilled at all the centers so determined. These holes should all be reamed to the same size—0.250 inch diameter, for example. A plug to fit these holes is turned up in the lathe, and should not be removed before the work is completed. The stock for the forming tool is soldered firmly to this master plate, this stock being left about 1/16 inch thicker than is required for the finished forming tool.



Method employed in making Master Plate and Forming Tool

The work is clamped to the face-plate of the lathe so that the hole in the master plate locating the center of one of the fillets at the bottom of the tooth space fits over the plug in the lathe. The holes in the illustration of the master plate are numbered to show the order in which they should be placed over the plug. The hole for the fillet is drilled to the exact size called for. The hole forming the other fillet is then made in a similar manner. After the two fillet holes are finished, the work is set up in a shaper to machine the radial grooves, as shown in the illustration, that form the flanks of the teeth. Using the hole in the master plate representing the center of the gear, and with the two fillet holes to work from, the work is very readily and accurately set up.

When both grooves are finished, the work is replaced in the lathe with the hole in the master plate locating the center of the gear over the plug. A groove is turned about 1/16 inch deep with its inside edge exactly tangent to the edge of the fillet holes, as shown in the illustration. When the correct diameter is found, the lathe is turned back and forth by hand, stopping at the points of tangency, until the forming tool is cut through. Stops should be attached to the spindle of the lathe to prevent over-travel. The hole locating the center of the radius forming the outer part of the face of the tooth is next placed over the plug. Another circular groove about 1/16 inch deep is turned when the proper diameter is found. The stock for the forming tool should be left large enough so that a full half circle may be turned and measured. After this diameter is found, the lathe is turned by hand, as before, until the forming tool is cut through as shown. The arc forming the other face is then made in the same manner.

The work is next moved again so that the center of the circle forming the tooth at the pitch line is over the plug, and this diameter is found in the same way. After the form is finished, the scrap pieces shown in cross-section are removed from the master plate; the forming tool is next faced off smooth and is then ready to be backed off. To back off the tool, the work is set up in the same manner as for first forming it, while the upper slide of the lathe or the tool-slide of the shaper is set at the proper angle. A slight flat or land is left at the cutting edge of the tool. This tool will not allow of much grinding, but after the master plate is made, new forming tools may be quickly made when needed. When the forming cutter is finished, the gear-cutter is made in the usual manner.

A similar method is found to be very accurate when making blanking and piercing punches and dies, the same master plate being used for both punch and die. Drill jigs may also be bored by this method, when extreme accuracy is desired. If, in any case, the centers of the different radii should be so close together that the holes for the plug could not be bored in the same master plate, another plate is doweled to it containing the other holes. I have known of cases where three or four plates were used.

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* * *

STANDARD SIZES OF CATALOGUES

A committee of the American Society of Mechanical Engineers has made extensive investigation of the various sizes of catalogues in common use, and in a report presented to the society the committee recommends that the standard size of catalogues be made 6 by 9 inches, but that an additional size for bulletins and large catalogues may also be considered as standard, this size being 8½ by 11 inches. For folders, two sizes are also recommended, *viz.*, small folders to be 3⅜ by 6 inches, and large folders, 3¾ by 8½ inches.

For paper covered catalogues intended to be permanently filed, the edges, including the cover, should be trimmed to exact size. No fancy deckled edge should be used. Overlapping edges of the cover should be used only when the catalogue is bound in covers stiff enough to support its weight when resting on the cover edges. Whenever possible, the title should be printed on the exposed back of the catalogue and should read from the top downward. Every catalogue should have the date of its publication on its title page and it is recommended that a standard size index card, 3 by 5 inches, be enclosed in every catalogue, with the title of the book and a brief statement of the character of its contents printed on it.

* * *

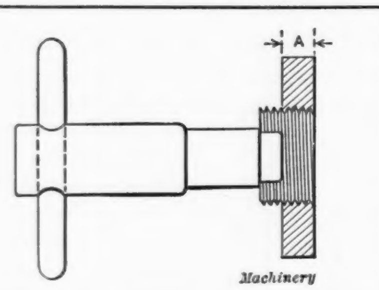
If a good color is to be obtained on brass castings, it is necessary that new metals be used, as a large percentage of scrap in the castings is indicated by a dull color. To produce a good luster on castings which are not machined to any great extent after casting, use at least two-thirds of new metal. An alloy extensively used in the brass trade consists of 88 pounds of copper, 3½ pounds of tin, 6 pounds of zinc, and 2½ pounds of lead.

STANDARDIZATION OF PIPE THREAD GAGES

The following information relating to standards for Briggs pipe thread gages has been abstracted from the report of a Committee on the Standardization of Pipe Threads appointed by the American Society of Mechanical Engineers. The purpose of the Committee on Standardization of Pipe Threads has been to fix manufacturing limits for the use of the Briggs standard pipe thread gages when tapping fittings or flanges, so that pipe cut to the Briggs standard might always enter a definite number of turns. Although the Briggs standard is used almost universally for pipe threads in the United States, the method of its use for female threads has not been established, in that no determinations have ever been made of the standard depths to which hand plug gages should enter. This has resulted in much confusion in the past, inasmuch as pipe threaded to the Briggs standard is liable to vary in the number of threads it would screw into fittings tapped at different shops. This tendency is so marked that pipe fitting is handled in practically all cases by sending the flanges to the shop where the pipe is cut, to be sure of satisfactory results.

This matter is conceded to be a simple one in that all it requires is an agreement among the manufacturers of fittings

STANDARD THICKNESS OF PIPE RING GAGES



Pipe Size	Thickness A, Inches	Pipe Size	Thickness A, Inches
1/8	0.1801	1	0.400
1/4	0.200	1¼	0.420
3/8	0.240	1½	0.420
1/2	0.320	2	0.436
3/4	0.339	2½	0.682

Pipe Size	Thickness A, Inches
3	0.766
3½	0.821
4	0.844
4½	0.875
5	0.937
6	0.958
7	1.000
8	1.063
9	1.130
10	1.210
12	1.360
14	1.562
15	1.687
16	1.812
18	2.000
20	2.125
22	2.250
24	2.375
..	.....

as to the point at which a ring should be attached to the gage, to establish, when the gage is inserted by hand, the proper depth of the thread. To this end the committee has met in conference with representatives of the manufacturers and also of the committee of the Society on International Standards for Pipe Threads. Mr. C. A. Olson, chairman of the Manufacturers' Sub-committee on Pipe Thread Gages, stated at this meeting that his committee had made a study of present practice among the various manufacturers and had adopted tentative definitions of the gages to be used, of the proposed thickness of ring gages acceptable to the manufacturers, and of the tolerances to be allowed. These he submitted as follows:

The gages shall consist of one plug and one ring gage of each size.

The plug gage shall be the Briggs standard pipe thread as adopted by the manufacturers of pipe fittings and valves, and recommended by the American Society of Mechanical Engineers in 1886. The plug is to have a flat or notch indicating the distance that it shall enter the ring by hand.

The ring gage is to be known as the American Briggs standard adopted by the Manufacturers' Standardization Committee in 1913, and recommended by the American Society of Mechanical Engineers, the committee on International Standard for Pipe Threads, and the Pratt & Whitney Co., manufacturer of gages. The thickness of the ring is given in the accompanying table. It shall be flush with the small end of the plug. This will locate the end of the flat on the plug flush with the large side of the ring.

When using the plug gage, as shown in the illustration accompanying the table, the flat indicates the exact size, and the allowable limits should be one thread large or small. When using the ring gage, the male threads are to gage when the plug gage is flush with the small end of the ring. The allowable limits are one thread large or small. A set of these gages to be known as the "American Briggs Standard for Pipe Threads" is to be deposited with the Bureau of Standards at Washington, D. C.

* * *

HEAT AND LIGHT OF THE SUN NOT REAL

Edwin F. Naulty, in an article published in the *New York Herald* March 15, states that the sun is not hot, despite all that has been taught to the contrary for thousands of years and the apparent evidence of our senses. He sets up the theory that the sun does not radiate light and heat and that the actual body of the sun is probably cool. The tremendous energy poured forth by the sun is not light and heat initially. Solar energy is invisible and is without temperature. Not until the rays of solar energy enter the atmosphere of the earth do they become light and heat. He likens the atmosphere of the earth to a huge spherical transformer which, by resistance, changes cold and invisible solar energy into light and heat, precisely as the filament in an electric lamp transforms the cold and invisible electric fluid that feeds it into light and heat. Only the solar rays entering the atmosphere of the earth or that of any other planet are so transformed. All other rays pass outward from it into space as cold and invisible as when they leave the sun. Outside the atmosphere of any planet is utter darkness as complete and absolute as if there were no sun.

Mr. Naulty affirms that the fact that the gases composing the outer shell of the sun are in a state of violent motion does not necessarily mean that they are on fire. An observer on the moon looking at the earth while a tornado was raging would see the atmosphere of the earth apparently on fire. Violent motion does not mean flames. In the upper levels of the earth's atmosphere the winds sometimes blow at the high rate of five hundred miles an hour and yet they remain cold.

If the sun were made of the best steam coal and were burning up it would be wholly consumed in five thousand years. If the sun were constantly pouring out heat, the solar system, in all these myriads of millenniums it has been in existence, would, by the cumulative effect, have become so superheated that the earth, the moon, Venus and Mercury would long ago have been expanded to gases. A burning sun is poor mechanics and a burning sun is a wasteful way of running the solar system. Because it is a wasteful way and because it is not mechanically perfect we may be sure that it is not the way heat and light are produced.

Mr. Naulty advances the theory that the energy of the sun which we perceive as light and heat is due to an electrical flux in the equatorial plane. The greatest strength of this electrical flux is exerted within a zone of about twenty degrees in width. The sun is considered to be a great combined generator and dynamo, deriving its initial energy from the entire solar system and, in turn, changing this into a radiant energy that spins the planets in their orbits and furnishes the invisible force which the atmospheres of the planets, in their turn, transform into light and heat. He claims that the theory of contraction of the sun as a means of generating light and heat is absurd and that of meteorites producing it by falling into the sun is equally absurd. In fact he denies the possibility of meteorites falling into the sun because it is the center of the solar system. As proof that the atmosphere of the earth is the transformer which changes the radiating energy to light and heat, he calls attention to the fact that at the equator the perpendicular rays of the sun at noon may be so energetic that the thermometer will stand at 120 degrees F. while at a distance of a mile above the temperature will be only 70 degrees and at a height of three miles on the mountains in Equador, we find the mercury below the freezing point, and still at each of the three points the thermometer is under the perpendicular rays of the sun.

LETTERS ON PRACTICAL SUBJECTS

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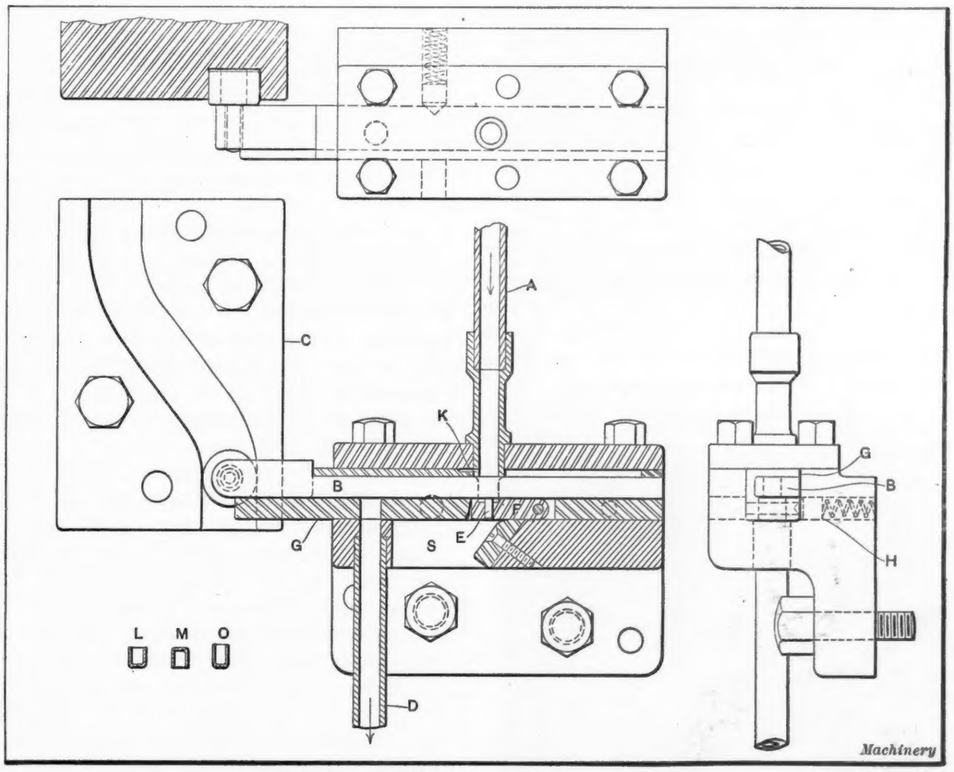
AUTOMATIC FEED MECHANISM FOR SMALL BRASS CUPS

The accompanying illustration shows an attachment for a press for heading the small brass cups shown in the lower left-hand corner. These are called "battery cups" and are used in shot-gun shell cartridges. The attachment was designed with the object of preventing broken tools and rejecting all cups that had not previously been trimmed to length. The cups feed down through the supply pipe *A* from the usual feed hopper, in the position shown at *L*. Slide *B* is reciprocated by the plate cam *C* carried on the cross-head. The cup is picked up by the cavity in slide *B* and is carried over and dropped into the supply pipe *D*, from which it passes to the feed dial. It sometimes happens that the cup will find its way into the feed pipe *A* in an inverted position, as indicated at *M*. When it enters slide *B* in this position it falls into the cavity around pin *E* and slide *G* is carried over along with slide *B*. The function of pin *E* is not primarily to catch the cups that fall with the mouth downward, but to hold up the cups that fall with the head downward, so that the bottom of the cups is level with the bottom of the slide *B* under normal conditions. When, however, the cup falls with the mouth downward over pin *E*, which is riveted in hinge *F*, the latter drops down over a hardened block, as slide *G* is carried forward, and the inverted cup drops out through cavity *S*. Slide *B* then returns slide *G* to its former position during the return stroke. Normally, the slide is held in position by plunger *H*.



Automatic Feed Mechanism for Small Brass Cups

A cup that is too long or that has not been previously trimmed, as at *O*, is caught by the edge *K* of slide *G*; the slide is then carried forward and the cup dropped out through cavity *S*, as before.

LAWRENCE FAY

SHOP EMPLOYES' SAVINGS AND LOAN DEPARTMENT

The particular advantages and benefits of encouraging a savings and loan department among shop employes are effectively shown by the results obtained at the plant of the Celluloid Co., of Newark, N. J. The Savings & Loan Department of the Celluloid Club, composed of about four hundred male and female operatives of the company, has recently issued a statement of its work for the past six months, showing total deposits of $11,500, or an average individual saving of approximately $29. This sum represents the savings of the rank and file of the shop workers, exclusively. The department is operated by employes for employes, without any assistance from officials of the company, or deposits from salaried or higher paid associates; and it is entirely separate from any other branch of welfare work carried on by the company.

This department of the club has now been in operation slightly over seven years, during which period its deposits have aggregated about $130,000. The organization of such a branch was the idea of President Lefferts of the company, offering a practical plan for the encouragement of the saving habit among its members; and it has proved a popular success from the start. The savings end of the department is operated in periods of six months duration. These are known as "series," and the regular withdrawal dates are in December, just before the mid-winter holidays, and about the middle of June, prior to the summer vacation season. The loan branch of the department renders temporary financial assistance to the depositors, and in this particular has shown that the lending of money to employes who are known to be steady and conscientious workers is a logical and safe departure. Beyond this, it eliminates the necessity for such employes to seek outside aid when in need of funds, and the attendant disheartening features of customary loan brokerage methods.

Members are privileged to borrow sums ranging from $1 to $200, at a charge varying from two per cent a month to six per cent per annum. The particular amount which the borrower has on deposit does not affect the extent of the loan allowed; an employe may deposit twenty-five cents at any time, and immediately obtain the maximum of $200. In the case of minors, however, the department requires the approval in writing of the parent or guardian for all loans desired in excess of $10.

Under regular conditions, no indorsement is needed for loans under $25, but above this sum an additional responsibility is requested in the form of a second guarantor, this usually being the written indorsement of a trusted employe. Notes given for loans are limited to a period of three months, and are renewable upon maturity. Borrowers must make weekly deposits to the fund, the object being to assist them out of their financial difficulty, as the borrowing of money is not encouraged for financial benefit of the department.

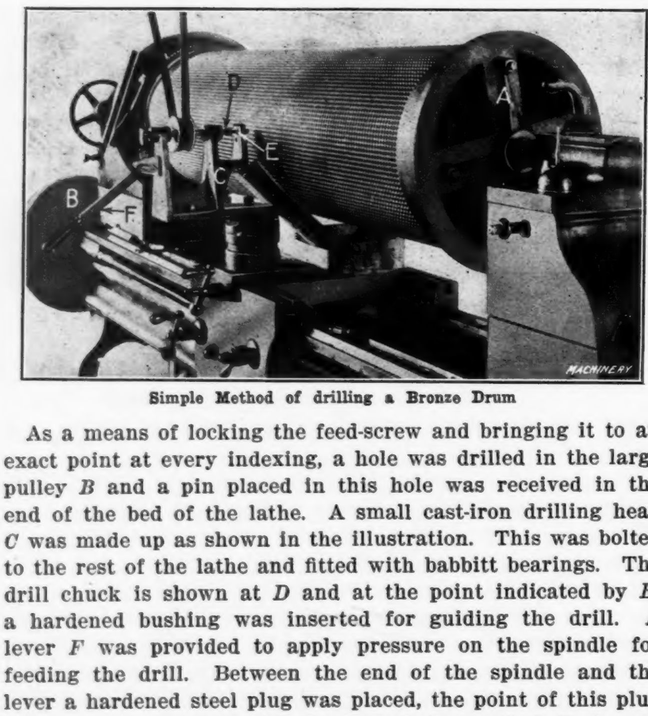
Should a borrower fail to keep an agreement to enter regular deposits, or fail to pay a note when due, the further advantage of accommodation for future loans is lost, as the department will not permit loans to such a member. Following the payment of a loan, the transaction becomes known by number, and the borrower's name is taken from the regular record of business. By loaning money on character in this

manner, the department encourages honesty and thrift among employes, and indirectly impresses them with the value of good habits and integrity in business. A. R.

DRILLING A BRONZE DRUM

A problem of drilling was placed before us a few days ago that had to be handled with the equipment ordinarily found in machine manufacturing plants. As it was out of the ordinary line of work, a few special fixtures were necessary. The piece in question was a bronze drum with an outside diameter of 23⅜ inches, bored inside so as to leave a wall practically ½ inch thick. It was necessary to drill this piece so that the spacing of the holes was exactly ½ inch from center to center, the size of the drilled holes being 3/16 inch. After the drilling operation was completed, the top or outside diameter of the drum had to have these holes countersunk with a countersink of 45 degrees angle and to a sufficient depth so that it would allow a little flat surface of the actual diameter between the countersunk portion and the surface of the drum practically 1/32 inch wide.

The drilling had to be done accurately, and in order to handle this work the following means were resorted to. Having a lathe large enough to swing the diameter of the drum and also take it in between centers, it was decided to do the work on this lathe. Two cast-iron plates *A* were made and shoulders turned on them so as to set in each end of the bronze shell, serving as heads. Hardened plug centers were inserted in the center of these heads, and four ⅝-inch bolts were placed in the four arms so as to bolt the two heads together and make them fast with the shell. The head nearest to the faceplate of the lathe was used as an index and 128 V-notches were cut in it. An index finger was provided on the faceplate of the machine. The spindle was locked and the front bearing of the lathe bound to hold it from any lost motion. As the feed-screw on the machine was 4-pitch, it was used for indexing the holes longitudinally, and by two turns of the feed-screw the spacing of ½ inch was obtained.



Simple Method of drilling a Bronze Drum

As a means of locking the feed-screw and bringing it to an exact point at every indexing, a hole was drilled in the large pulley *B* and a pin placed in this hole was received in the end of the bed of the lathe. A small cast-iron drilling head *C* was made up as shown in the illustration. This was bolted to the rest of the lathe and fitted with babbitt bearings. The drill chuck is shown at *D* and at the point indicated by *E*, a hardened bushing was inserted for guiding the drill. A lever *F* was provided to apply pressure on the spindle for feeding the drill. Between the end of the spindle and the lever a hardened steel plug was placed, the point of this plug that comes in contact with the lever being made ball shaped. Between the pulley and front bearing of the drilling head there was a small spiral spring which returned the drill automatically ready for drilling another hole.

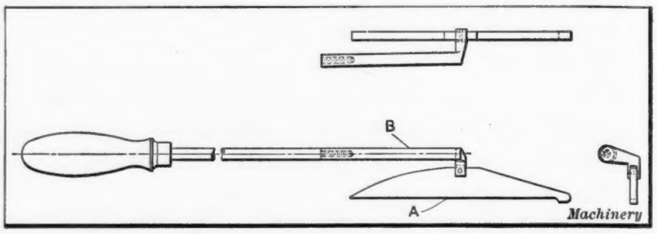
The drilling of this drum required two operators, one for indexing and the other for feeding the drill. The number of holes drilled in the shell was 16,512. It is usually thought that work of this class requires a special machine and the illustration of a method of handling this type of work in a simple way will, no doubt, be of interest to readers of MACHINERY. The drilling and indexing of the 3/16-inch holes was at the rate of about six holes per minute. It will be seen from this that it required but a few seconds per hole to index the work. This work was performed at the plant of the J. N. Lapointe Co., New London, Conn.

New London, Conn. FRANK J. LAPOINTE

MAGNET FOR DETERMINING HARDENING TEMPERATURE OF STEEL

A piece of tool steel loses its power to attract a magnet when its temperature has been raised up to or beyond the point of decalescence at which it should be quenched for hardening. This fact has been taken advantage of in determining hardening temperatures, for which purpose various forms of magnets have been designed to test the temperature of the steel while in the furnace. The accompanying illustration shows a convenient form of magnet, and by following the instructions outlined for using it, very satisfactory results can be obtained.

This tool consists of a piece of magnetized steel *A* which is pivoted to the arm *B* so that it is free to swing. The arm



Useful Form of Magnet for determining Hardening Temperature of Steel

B is made of brass or some other non-magnetic metal, and the magnet is pivoted so that in the event of differences in temperature between parts of the work, either end of the magnet can swing down to indicate such an inequality in the intensity of the heat at different sections of the furnace. It will be seen that a hook is formed at the end of the magnet opposite the handle, for the purpose of drawing light pieces of work out of the furnace when the desired temperature has been reached.

In testing the temperature of steel in this way, the magnet is brought into contact with the work at frequent intervals as it is heated in the furnace, and the steel will continue to attract the magnet until the desired hardening temperature has been reached. When the magnet ceases to be attracted by any part of the steel, it shows that the proper hardening temperature has been attained; and the work should then be withdrawn from the furnace and quenched. Frequent tests should be conducted during the heating of the steel, and care should be taken not to allow the magnet to become too hot. This makes it necessary to withdraw the magnet from the furnace immediately after making each test.

Hartford, Conn. HENRY E. GERRISH

TO OXIDIZE BRASS BLACK

A method of oxidizing brass which I have used and found satisfactory is as follows: Prepare a solution of copper nitrate by dissolving pure copper in commercially pure nitric acid until all action ceases. This should be done in a large jar out of doors, as the chemical action throws off a dense brown vapor which will rust steel or iron, and the volume of the acid increases as it heats. After all action ceases and the mixture becomes cold, the clear liquid is decanted into another jar. Sand-blast the work or clean it thoroughly by some other method, so that it is free from grease of any kind. Work washed in a solution of hot lye and soda, dried in sawdust, and then kept from contact with the fingers or grease until the blackening solution is applied will give the best finish.

Heat the work to a temperature of about 212 degrees F., or the boiling point of water, immerse it in the copper nitrate solution, then remove and heat again until it is just hot enough to dry off the solution and to burn off the green color which appears. This process may be repeated, if it is thought necessary. The work is then cooled and all free

oxide removed by brushing, after which it is dipped in ammonia and rubbed dry with a soft cloth or in sawdust. This will leave the work with a brownish color. To get the dead black color, heat the piece to a temperature that is not high enough to burn the hands but very warm, and rub it with a piece of soft leather having a few drops of pure olive oil on it, after which it should be heated enough to dry the oil.

Highly polished work, if well cleaned and dipped in commercial ammonia before applying the copper nitrate, will take a permanent black. Work that is sand-blasted takes a black that cannot be removed by ordinary wear. Plates used to label steam valves are usually located in semi-dark localities. Good plates may be made for this purpose by stamping the letters into a piece of brass, sand-blasting and oxidizing them and then filling the letters with a mixture of chalk and ammonia. Different colors of chalk may be used and the letters show very plainly in a place where the light is dim. The chalk put in in this way will stand considerable handling before it is dislodged. This is the most permanent black finish that I have ever found and may be applied very economically in quantities.

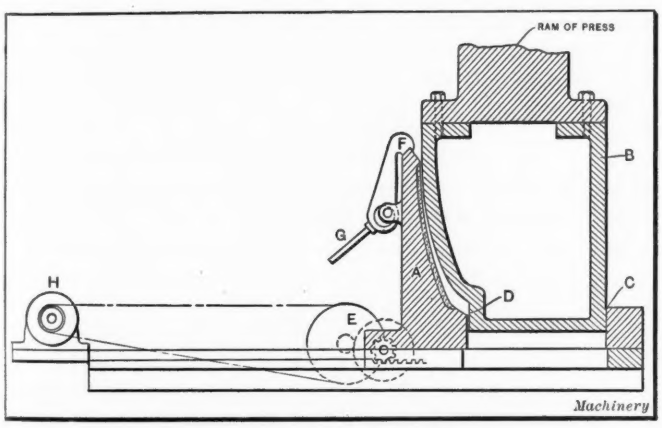
Southbridge, Mass. WARREN E. THOMPSON

DRAWING AN AUTOMOBILE TONNEAU

Some time ago we had an order for steel automobile bodies, and among other shapes we had the tonneau or back of the rear seat to form. The total height of this piece was 23½ inches, while the stroke of the only power press available for the work was 11½ inches. The method of doing the work that was finally adopted was as follows:

The punch *B* was cast and machined to size. The die *A* was fitted to *B* all around at *C* and *D*; the two were then put together and the recess in the die was poured full of type metal. Along the back, on the two sides and the front edges, clamps *F* were fitted; these were operated by eccentric cams. The whole die was fitted to a slide and suitable gearing was provided at *E* to move the die in or out. This gearing was driven by a motor *H* wired to run in either direction.

In operation, the blank was first cut to shape; then the top edge was slit in about 2½ inches at spaces a few inches



Die for forming an Automobile Tonneau

apart, and it was then formed in a die to a V shape so that when the blank was bent to a U shape by the operators and dropped into the die, the top edge fitted on the top of the die, ready for the clamps *F* to engage. The piece was put in place and the side and back clamps locked with the die out at the end of its track. Then the die was run in to a position under the punch and the front edges clamped.

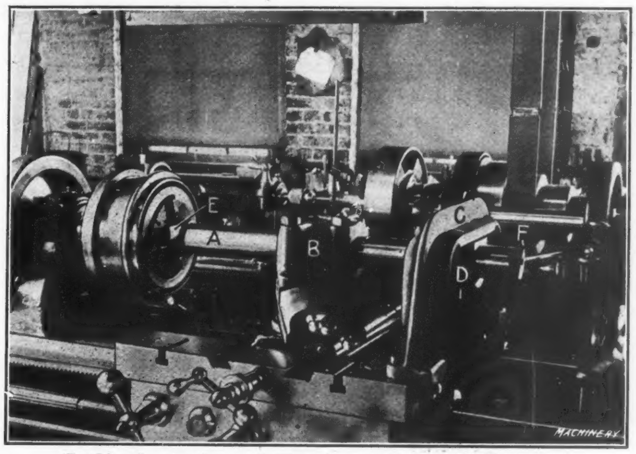
When the punch came down it engaged the backing at *C* and the metal at *D*. As the blank was firmly held at the top, the only place it could draw was from the bottom, and most of the shape was stretched from the metal itself. The die worked fairly satisfactorily and several thousand pieces were formed with it. The blank used was considerably wider than the finished piece, allowing it to project down into the straight part of the die and provide metal to draw from.

This is not offered as the best possible way of doing a job of this kind, but it was the only way possible with the equipment at hand. It is probable that most of the tonneaus in use today could not be made by this method, because the difference in size at the top and bottom would be so great that the metal could not be stretched sufficiently to form them without breaking.

Philadelphia, Pa. W. A. VALENTINE

RIGID BORING AND THREADING TOOL

An unusually stiff bar for boring and threading high-speed steel dies was needed, and to meet the requirements of this work, the bar shown in the accompanying illustration was designed. It is shown in use on a 16-inch Le Blond engine lathe and it was unnecessary to change the construction of the lathe in any way except to drill and tap three ⅜-inch holes for the cap-screws which hold the yoke *C* to the carriage.



Combination Boring and Threading Bar with Rigid Support

The design of this equipment differs from that of most rigs in that the strain resulting from the overhang of the bar *A* is carried by the yoke *C*. This yoke is provided with a finished pad on its under side, on which the shoe *D* slides to provide for transverse adjustment. Longitudinal adjustment is also provided to allow different lengths of the bar to project. The holder *B* has a tongue on its under side which enters the toolpost slot, and the holder is set at an angle of 29½ degrees, which has been found most desirable. A Novo steel thread chaser *E* is shown working at the end of the bar, and at the opposite end of the bar there is a Novo steel bit *F*. The same bar is available for both boring and threading operations, it being merely necessary to change it end for end. This bar was made of two-inch extra-heavy pipe plugged at each end. The depth of cut and the coarseness of the feed which can be handled are dependent upon the rigidity and pulling power of the lathe.

Pottstown, Pa. CLAYTON DANE

LAYING OUT GEAR-CUTTER FORMS

In the January number of MACHINERY, How and Why section, A. J. T. asks for information relating to gear-cutters. The writer does not pretend to know the method used by gear-cutter makers—they seem to try to keep this matter very secret—but offers the following which has been used in actual practice several times and given satisfactory results.

Some time ago, the writer was employed in a factory where a machine was built in which the teeth in a gear transmission were required to be as nearly correct as possible. The shape of the teeth had to be correct for the exact number of teeth in the gear and pinion, in as far as theoretical accuracy was commercially possible. This requirement eliminated the circular cutter method of milling with standard cutters, as these are correct only for a certain number of teeth, and only approximately correct for the great majority of numbers of teeth in the range covered by one cutter. The gears could have been cut on a Fellows gear shaper and the desired results obtained, but there were other conditions which prevented this, so it was necessary to use a circular cutter. A special cutter, however, had to be made. The writer was given the job and

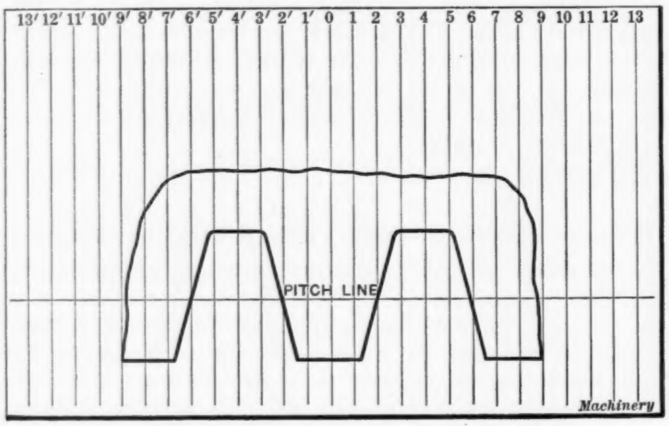


Fig. 1. Short Section of Rack laid out on Enlarged Scale

looked for information on the subject everywhere, but without success.

Starting, however, from the fact that if two gears work perfectly with a rack they will also mesh perfectly with each other, the following method was devised: On a piece of paper lay out a short section of a rack as carefully as possible to correct proportions, and on an enlarged scale, say ten times full size. Make arbitrary divisions and draw lines parallel to the center line, numbering them as shown in Fig. 1. Now on a piece of tracing paper or cloth, draw a center line and scribe the pitch circle, top circle and clearance circle of the gear required, to the same enlarged scale as the rack tooth. Lay off divisions on the pitch circle, draw lines toward the center, and number them as shown in Fig. 3. The divisions on the pitch circle, Fig. 3, are, of course, equal in length to the divisions in Fig. 1. The zero line on the rack is in the center of a tooth and the zero line on the gear will be the center line of a space. The tracing should be tacked firmly to the drawing board. Now slip the rack drawing under the tracing so that the pitch and zero lines coincide, and trace the rack tooth on the tracing cloth. Move the rack drawing so that lines No. 1 coincide and then trace the tooth as before. Do this with every position on both sides of the zero line, and the result is a drawing showing the positions which the rack tooth would occupy if a rack and gear were rolled together. Through the points and lines thus determined draw curves, and we have the exact shape of a formed cutter which will cut an accurate gear. The shape, of course, is on an enlarged scale. Determine the outline by filling in on the tracing with solid black ink. Then draw around the shape thus determined a rectangle *ABCD* of such dimensions that the sides are conveniently divisible by 10, if ten times the natural size has been chosen as the scale.

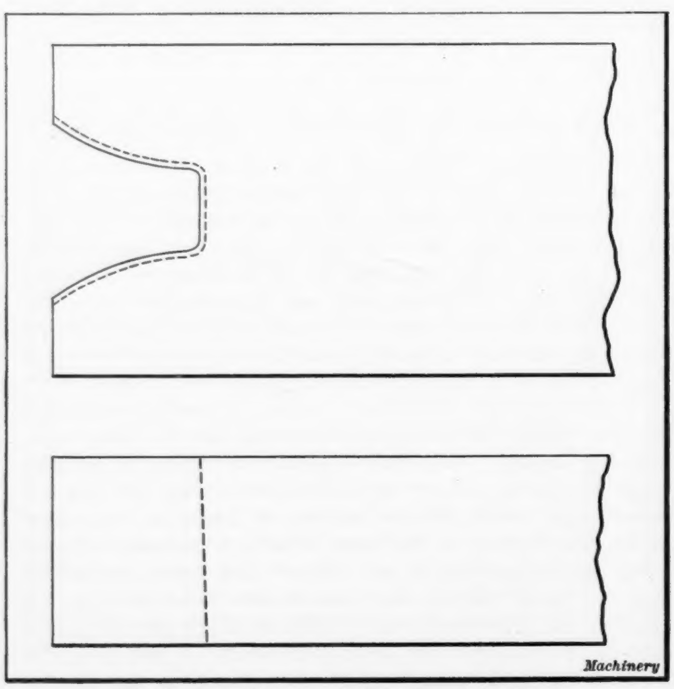


Fig. 2. Formed Tool made from Layout in Fig. 3

The next step is to reduce the tooth outline by photographic means to the natural size. On the ground glass of the camera draw a rectangle one-tenth of the rectangle *ABCD* in Fig. 3. Pin the drawing squarely in front of the camera and focus so that the rectangles match up correctly. Expose the plate, and develop and print by the usual methods. We have now prints showing the exact shape and size of the cutter tooth as nearly correct as it is possible to get them. The next step is for the toolmaker to make a flat cutter from these, as shown in Fig. 2. This is the most difficult part of the work, but it is not as difficult as one might think, when carefully carried out.

The circular cutter is now made, and, after having been rough-turned as nearly to shape as possible, the formed tool, Fig. 2, is used to finish off with a light cut. After the cutter has been gashed to form the teeth, the formed tool is used to

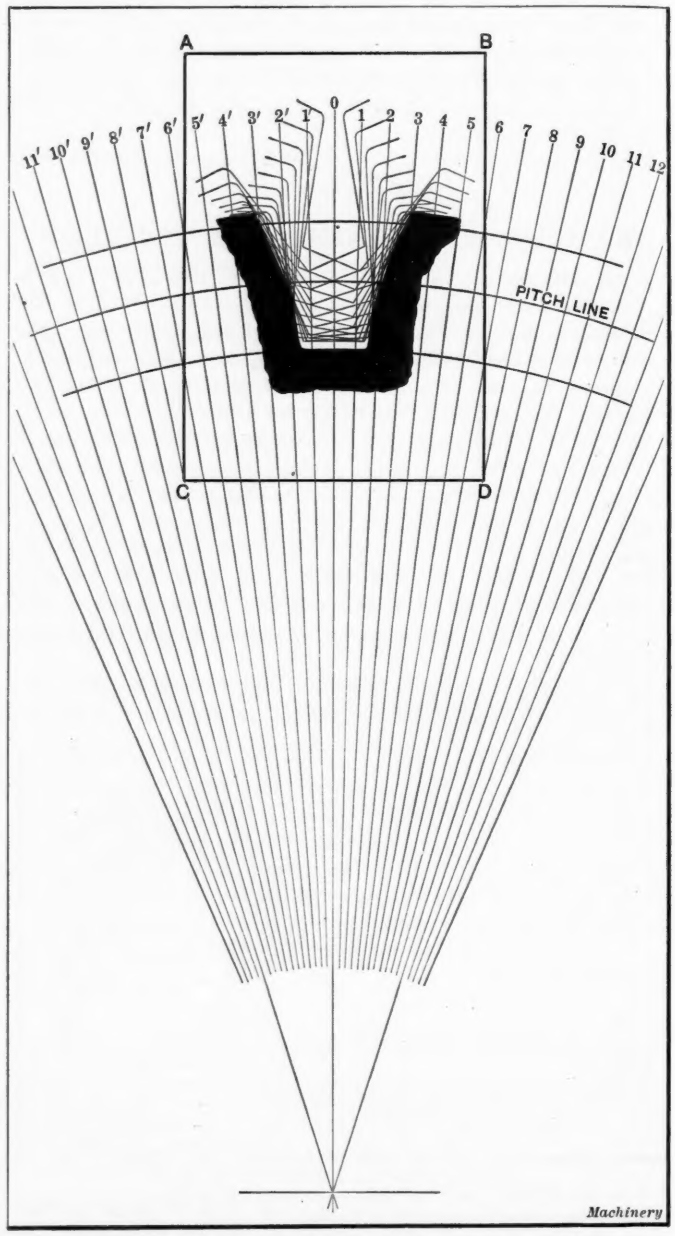


Fig. 3. Tracing of Rack Tooth in Various Positions, giving Form of Gear-cutter

back off or relieve the teeth, preferably in a backing-off machine or in a lathe with a backing-off attachment. If neither of these means is available, the next best way is to pull the belt of the lathe by hand, with the back-gears in, and feed by the cross-slide for each tooth. All that now remains is to harden the cutter carefully and grind the faces of the teeth.

Pawtucket, R. I. RICHARD W. DICKINSON

MEAN CIRCUMFERENCE OF A RING

The usual formula for obtaining the mean circumference of a ring of the form shown at the right-hand side of the accompanying illustration is:

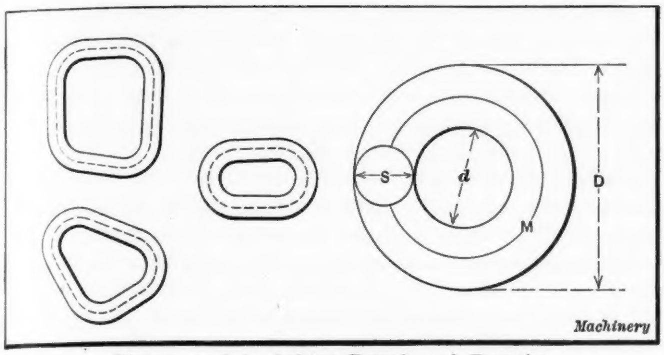


Diagram used in deriving Formula and Examples of Odd shaped Rings

$$\text{Mean circumference} = \pi \times \frac{D + d}{2}$$

where D and d are the inside and outside diameters.

The length L of the wire in a spiral is given by the following:

$$L = N\pi \times \frac{D + d}{2}$$

where N is the number of coils in the spiral.

In working on a certain device where there were a number of rings of different shapes, and in such positions that it was only possible to measure the periphery and the diameter S of the wire, the following formulas were found more convenient to use:

Mean circumference $= \pi\,(D - S) = \pi\,(d + S)$.

Similarly, for spirals, the length L of the wire is given by the following formula:

$$L = N\pi\,(D - S) = N\pi\,(d + S).$$

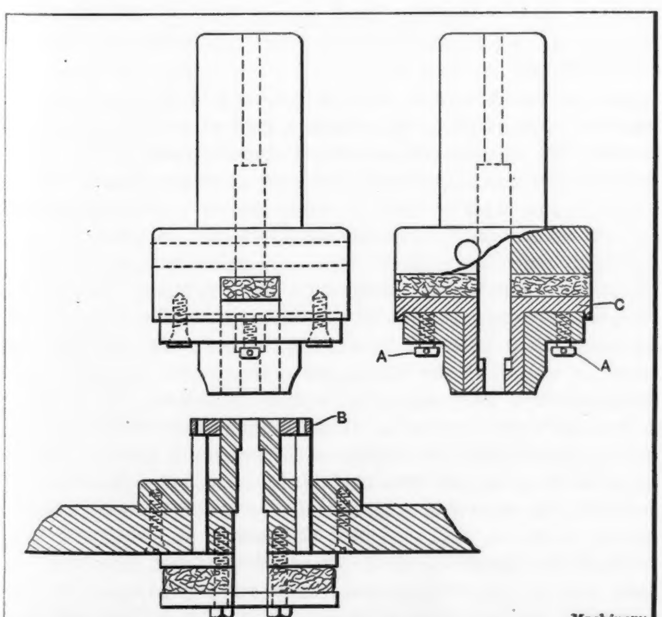
The three small rings shown at the left-hand side of the illustration are examples on which these formulas can be used to advantage.

Syracuse, N. Y. E. J. ENGMAN

DIE FOR MICA WASHERS

The die shown in the accompanying illustration was designed for cutting small mica washers. The familiar form of punch and die made with a leader to push the blank down through the die does not work well on mica, as the material has a tendency to flake off and stick to the bottom of the punch. Mica is also found to wear a die of this form very rapidly. In handling mica in a punch and die, the material should be put in a bath of turpentine and kept in the liquor until it is to be worked up under the press.

The die illustrated in this connection gives good results in making mica washers and affords the operator plenty of room



Compound Die for cutting Mica Washers

to handle the strips of mica. He is able to see through the material to locate it in position over the die so that unnecessary waste will be avoided. The screws A are used in setting the die. By turning them up, the ejector C is forced into the rubber pad. The stripper B is next raised and lifted out. It is made free enough to be drawn up by hand. Then the punch and die may be put together ready for setting up on the press; after setting, the stripper B is put back into place. Guide pins could be used but they would be in the way in operating the die on scrap stock.

Stamford, Ontario, Can. R. WILCOX

JIG AND FIXTURE DESIGN

In the December number of MACHINERY, I noticed an interesting article by "Server" describing a variety of clamping devices applicable for use in jig and fixture design. I would like to suggest a few methods that practice has proved to be superior to some shown in the article referred to.

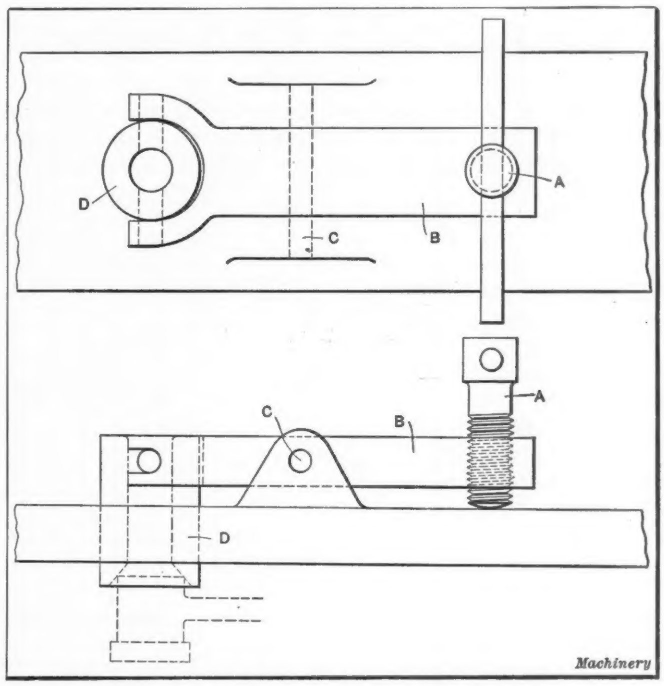


Fig. 1. Good Substitute for Bellmouthed Bushing

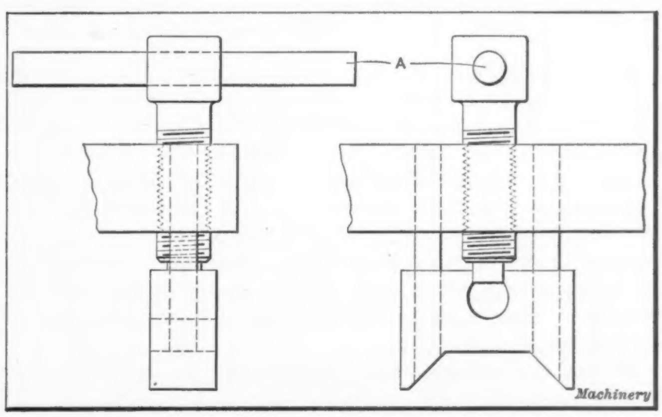


Fig. 2. Superior Method of turning Screw Clamps which avoids Sore Hands

Fig. 5 of "Server's" article showed a bell-mouthed screw bushing which locates and clamps the work for drilling and reaming. This style of bushing requires an extra long drill, and if made with two sizes of holes, as shown, particular care will have to be taken in using small drills to prevent breaking a number of them. Another objectionable feature of this clamping device is that chips work into the threads and prevent turning the bushing easily; this also shortens the life of the thread.

Fig. 1 of the present article shows a clamping device which, although a little more expensive, the writer believes to be far superior to "Server's" method. This device would prob-

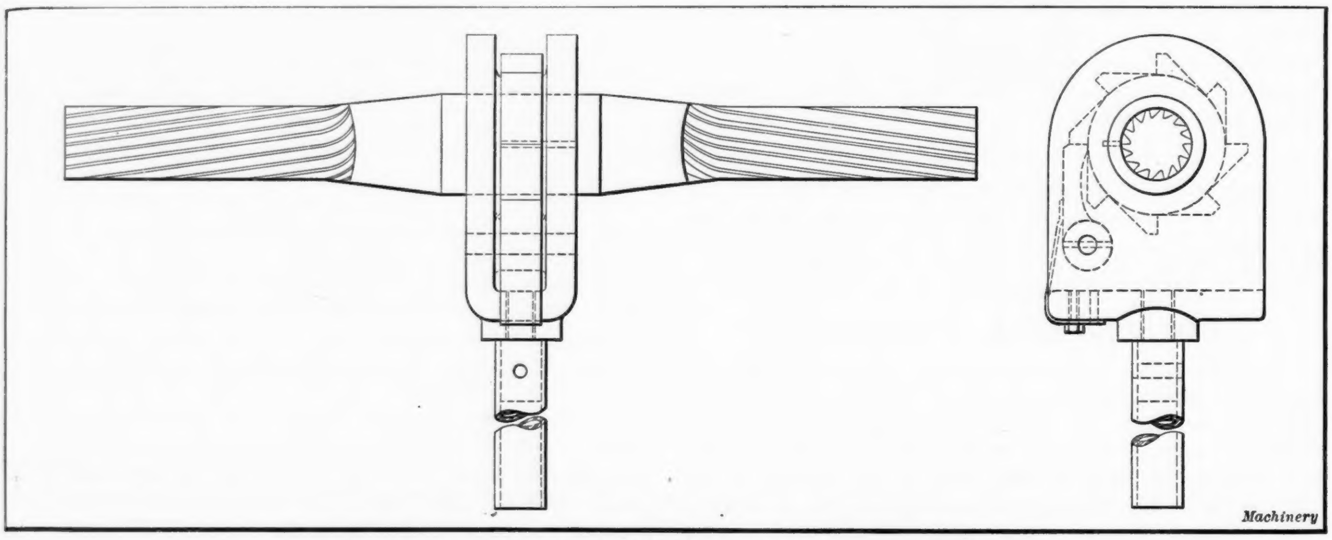
ably pay for itself in saving the breaking of drills, as the bushing on this jig can be made shorter and with one sized hole. Little explanation is necessary to make the operation of this device clear to any mechanic. The screw *A* swings the lever *B* about pin *C* and pushes down the bushing *D* which is a slip fit in the body of the jig.

Figs. 9, 10, 11 and 15 in the article previously referred to showed jigs in which a cast-iron knob was employed for turning the clamping screws. I have seen operators with sores on their hands which were caused by manipulating these cast-iron screw knobs. If it is necessary to use a hand-screw for clamping work in a jig, the design shown in Fig. 2 of the present article will be found far superior. A screw of this kind is cheaper to make and does not injure the workman's hands, as the pin *A*, which is pressed into the head of the screw, may be 3 or 4 inches in length, thus affording ample leverage for tightening the screw. The only reason that I can see for using a cast-iron screw knob is that it looks well in the drawing.

Detroit, Mich. CHARLES STAPLES

REAMING FIXTURE FOR CAM-SHAFT BEARINGS

A great deal of time and labor is required to properly scrape a bearing by hand, and any tool or fixture that will do better work or assist the operator to do the work in a short space of time is a money saver. The reaming fixture shown in the accompanying illustration was designed to overcome the difficulty we had experienced in scraping the bearings for oil engine cam-shafts by hand. These bearings were always babbitted in place in the crank-case by means of a special babbitting mandrel which was designed to bring the cam-shaft bearings in proper alignment with each other, and in the proper relation to the crankshaft bearings. The hand scraping was slow and unsatisfactory and ordinary reaming was of little assistance because of the impossibility of obtaining the required degree of accuracy.



Duplex Reaming Fixture with Ratchet Drive for finishing Cam-shaft Bearings

The spiral reaming fixture which forms the subject of this article is equipped with a ratchet handle for turning it. It will be seen that one right-hand and one left-hand spiral reamer are used, the two reamers being a single unit to prevent any tendency for them to draw away from or push against each other. By placing the reamers in the cam-shaft bearings and tightening the nuts down on the bearing caps, while turning the reamers by means of the ratchet handle, a smooth accurate bearing surface is produced. The bearings are brought to the proper size and in accurate alignment with each other in a very short space of time. M. W. W.

THE "FOLLOW-UP" ENGINEER

To sell a machine and then promptly forget about it until it is thought the same purchaser might be in the market for additional equipment, is fast becoming a selling plan that represents a relic of bygone days. It has long been conceded that a "satisfied customer is the best advertisement," but although this business axiom has been universally revered it has seldom been acted upon so as to really accomplish results. There is, however, a decided tendency toward the increased use of expert demonstrators; in fact, the expert demonstrator might be more properly called a "follow-up" engineer. The activity of the so-called expert demonstrator is no longer confined, by progressive manufacturers, to the aid his services may bring in effecting an immediate sale, but rather as a substantial means of building up a future business. It is in this respect that the activity of the expert demonstrator as a "follow-up" engineer can be made an influence for far-reaching good.

Let us assume that a number of competitive machines are at work in a certain machine shop. Each machine is capable of performing work up to a certain capacity, and if that capacity is not reached, the loss will be felt eventually by the builder of the machine and possibly to a greater extent than by the user. So long as a machine is permitted to be used under conditions that impair its efficiency, it remains a chronic injury to the reputation and business of the builder. Ordinarily, the services of an expert demonstrator circulating among the shops of the users of a certain machine are looked upon as entirely gratis on the part of the builder, but progressive firms have learned that such a practice is mutually beneficial. Aside from the enormous advertising value accruing from the fact that manufacturers' products are working up to a capacity that stamp them as efficient tools, there is an additional benefit to the manufacturers that is often entirely overlooked.

Let us assume, for example, that a grinding machine manufacturer employs as a regular part of the selling organization, the services of an expert demonstrator whose duty it is to visit periodically the shops of users of the product of his company with a view to assisting in bringing the machines up to an increased standard of production. Undoubtedly such an expert is in a position to lend material assistance to the manufacturer which, in itself, should be sufficient recompense. It will be just as readily appreciated, however, that such a circulating expert can also become of great value to the designing organization of the manufacturer whom he represents, in that he is constantly coming in contact with mechanics whose ingenuity is often a potent factor in increasing the utility of the machines they are using. In this way the manufacturer's representative has an opportunity of observing improvised improvements designed for special purposes, that can well be made a part of the design of improved machines as they are brought out from time to time. It is safe to say that many an improvement in the design of machine tools originated in the shops of users. In the same way that a shop that permits no visitors, probably

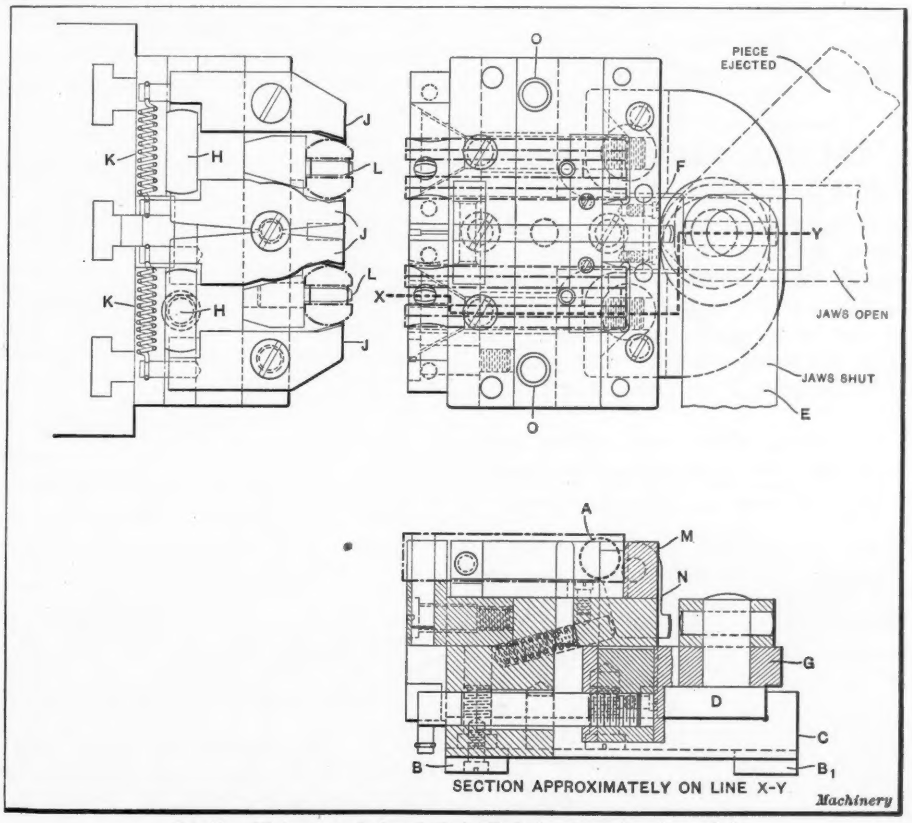
loses as much as it keeps away from competitors, the expert demonstrator learns as much as he dispenses.

A. V. Francis

FIXTURE WITH CLAMPING AND EJECTING DEVICES

The fixture shown in the end, plan, and sectional views of the accompanying illustration was designed for holding the two parts shown by the dot-and-dash lines, while the ends were being ground in an ordinary disk grinder. Each piece consists of two hardened steel strips, shaped as shown by the end view. These two strips are joined by a circular spacer *A*, to which they are electrically welded. The fixture is mounted on the sliding table of the grinder. When grinding, the ends are brought up against the abrasive disk, after which the work is moved back and forth across the face of the disk in the usual manner. The length of the parts is regulated by a stop on the grinder table.

This fixture was made of steel throughout and some of the details were hardened. The fixture is located on the grinder table by the tongue pieces *B* and B_1 attached to part *C*, which, in turn, is fastened in a slot formed in the main body. This member *C* takes the thrust of cam *D* which is operated by lever *E* and serves to clamp the work in position by means of the wedge and lever clamping arrangement seen in the end view. This cam, instead of having a fixed center, floats between parts *C* and *F* and is held sideways by yoke *G*. This yoke has enough swiveling motion to compensate for any inequality in the clamping, due to variations in the size of the work. The clamping bolts *H* are threaded into yoke *G* and have wedge shaped ends which engage the clamping levers *J*. The threaded connection allows for adjustment when the cam or other members become worn. The jaws *J* swivel about the screws shown and are normally held open by springs *K*.



Grinding Fixture so designed that Work is clamped and ejected from Locating Pins by a Single Handle

The work is located by pins *L* and the end-stop *M*. Owing to variations in the size of the work, some of the pieces stuck to the front pins *L* and could not readily be removed. To overcome this difficulty, the ejector *N* was provided to "strip" the parts from the pins. This ejector is operated by the same handle *E* which controls the movement of the clamping jaws. After the jaws are open sufficiently to release the clamps, a further motion of the handle brings it into contact with the end of ejector *N*, thus raising the front end and forcing the work off the pins. The holes marked *O* are used for clamping the fixture to the grinder table by means of screws and T-nuts.

One of the points that facilitated the operation of this fixture was that the handle moved to the left to tighten the jaws and this motion was continued after the work was clamped, thus pushing the grinder table, which moved freely, over toward the abrasive disk and in position for grinding. On the other hand, when the work was to be removed, the pressure on the handle necessary to release the clamps moved the table back away from the wheel.

Elizabeth, N. J. George R. Richards

ADVERTISING IN THE PROFESSIONS

There are many kinds of advertising but the object of all advertising is to increase business. The merchant who has goods that he wishes to sell at a profit buys newspaper space and uses it to tell buyers that his goods are the best obtainable for the money; but that is only one of the ways in which he advertises. His window display is an advertisement, he donates goods to fairs, gives prizes for contests, and, in fact, misses no opportunity to get his name and his goods before the buying public. He is not accused of lack of modesty when he praises his goods and claims that he has made the best selection possible when he bought his stock.

The professional man also has goods to sell. His stock in trade is his services, and the value of his services depends on his ability to get results. It is not good form for a professional man to buy newspaper space and use it to exploit the desirable qualities of his own services, but there are other ways of advertising his ability that are legitimate and are constantly used by professional men. You can hardly pick up a newspaper without seeing an item stating that Dr. So-and-So, the local expert on tuberculosis, delivered a lecture on the benefits of the Red Cross stamp fund, to the Woman's Club, or that Mr. Somebody, the noted lawyer, addressed the Chamber of Commerce on the working of the new income tax law, or that the Honorable Somebody-or-Other—congressman from the first district—addressed a mass meeting on the duty of congress to the people, and, once in awhile, we read of John Jones, the well known engineer, delivering a lecture on efficiency in every-day life.

In this day and age it is not only perfectly legitimate to advertise what you have to sell, but necessary for any large success, and if engineers advertised more extensively than they do their professional standing would be better recognized. It is true that the engineer is not interested in advertising his ability to the general crowd, in the same degree as is the doctor and lawyer; nevertheless, if Joe Brown, the factory superintendent, delivered a lecture to the business men on how to handle men, the "Boss" would be impressed with the fact that Joe did have less trouble with the men than his former superintendent. Furthermore, other bosses that heard the lecture or read of it would note that Joe had some good ideas and was the kind of man they would like to have in their organizations. The opportunities for delivering lectures to general audiences are limited, but one has a good audience at any meeting of the engineering societies to which he belongs. There is another medium, however,

that reaches a large and select audience and that is the technical magazines.

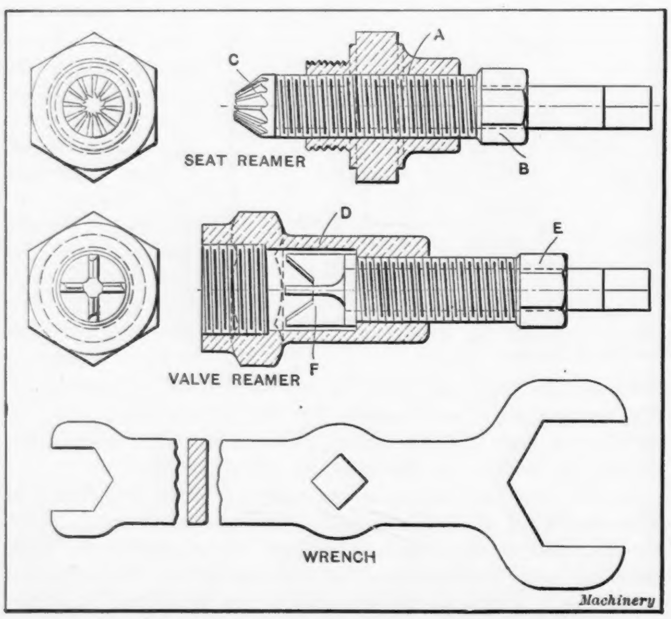
Advertising of this sort, whether it consists of lectures delivered personally or articles published, has a two-fold value: First, it secures a desirable publicity and, second, it provides an incentive for improvement. The man who delivers a good lecture or has a valuable article published begins to think he really does amount to something and he gets the ambition to do something better. He becomes so interested in his subject that it is a pleasure to burn the "midnight oil," digging up everything he can find on that subject, and he goes to the office or shop with a new interest, his field is broadened because his ideas are presented to people all over the world, and if his ideas are faulty, people from all over the world will tell him so, too. This puts him on his mettle to perfect his ideas and defend them, until he is soon looked upon both by others and himself as an authority in his line. When he has secured this result he has reached the same stage as the manufacturer who puts out a staple line of goods with a countrywide reputation. He can sell his services anywhere and the position he reaches is limited only by his ability and energy. This does not mean that advertising need be the only reason for presenting papers personally or through the press, but the advertising and the incentive to better and broader work, are enough to well repay any man for his trouble, and many a man made his start out of the rut in this manner.

NAVILLUS

TOOLS FOR TRUING VALVES AND VALVE SEATS

Keeping gage cocks in good condition is often a serious problem in districts where the water is bad. In such cases the sediment in the water has a tendency to cut the valve and seat. The usual method of grinding takes a considerable amount of time and on account of the difficulty that is experienced in holding the valve exactly in line with the seat during the grinding operation, it is not always possible to get a good tight joint.

The accompanying illustration shows tools which make it possible to grind valves and valve seats with a high degree



Tools used for truing the Valves and Seats of Boiler Gage Cocks

of accuracy. The parts of this outfit consist of a seat reamer, a valve reamer and a wrench for adjusting the parts. The body of the seat reaming tool A is screwed into the body of the gage cock, and the adjusting screw B is turned until the reamer C rests lightly on the seat. Then using the square hole in the handle of the wrench, it is only necessary to give the reamer a few turns in order to true up the seat. Similarly, the valve reamer body D is screwed onto the gage cock bonnet with the valve in position, after which the adjusting screw E is turned to bring the reamer F into contact with the valve. The valve is then trued up in the same way that the seat of the valve was refinished.

The importance of having the cutting face of both reamers of exactly the same angle is evident, for if they do not correspond it is obvious that the valve will not fit properly in its seat. These tools cut rapidly and the operator who uses them should be instructed to apply a very light pressure and to be careful not to ream away more material than is necessary to insure a good fit. Although these tools were designed for use on gage cocks, the design could be easily modified to produce a tool suitable for use on any common type of valve having the same style of seat.

Lincoln, Neb. H. E. GILLETTE

GAGE FOR SCREW MACHINE WORK

A type arm pivot made on the automatic screw machine is illustrated in Fig. 1, and an interesting form of gage for testing the accuracy of these parts is shown in Fig. 2. The thin ends of this part constitute the main bearings of the pivot and it will be seen that the limit of tolerance allowed is very small. Referring to the illustration of the gage shown in Fig. 2, it will be seen that the block A is secured to the base by means of two screws and two pins and that it is drilled to receive the gage B. This gage is a press fit in the block A. A similar block C is secured to the base and drilled to receive the gage D. This block is of greater length in order to accommodate the spring which returns the gage to its original position after it has been moved back by the handle E to allow the work to be put in place.

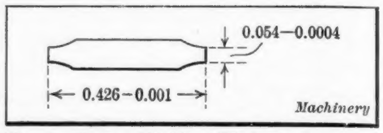


Fig. 1. Screw Machine Work to be gaged

To check the dimensions of a piece of work with this gage, the inspector pulls back the lever which moves the gage D

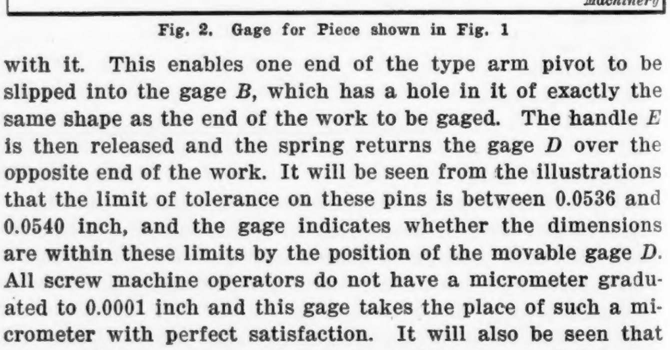


Fig. 2. Gage for Piece shown in Fig. 1

with it. This enables one end of the type arm pivot to be slipped into the gage B, which has a hole in it of exactly the same shape as the end of the work to be gaged. The handle E is then released and the spring returns the gage D over the opposite end of the work. It will be seen from the illustrations that the limit of tolerance on these pins is between 0.0536 and 0.0540 inch, and the gage indicates whether the dimensions are within these limits by the position of the movable gage D. All screw machine operators do not have a micrometer graduated to 0.0001 inch and this gage takes the place of such a micrometer with perfect satisfaction. It will also be seen that holes and slots are provided at the left-hand end of the gage for checking the dimensions of the large diameter and the length of the work.

LEO MORTON

* * *

Automobile engineering as a career will be made the subject of a series of talks before the engineering societies of various colleges, according to a plan that has been formulated by the metropolitan section of the Society of Automobile Engineers. The need of trained men is constantly felt in the automobile industry, and it is believed that it properly devolves upon this society to assist in attracting the attention of undergraduates to this field. Incidentally, the advantages of junior membership will be advocated as a means of getting into touch with current practice before engaging in practical work.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO REMOVE OIL VAPOR FROM COMPRESSED AIR

O. B. M. Co.—We are interested in a device for extracting oil vapor from compressed air. We use compressed air to blow bottles with our bottle machine, and the oil vapor, we believe, causes the inside surface of the bottle to become smoky. We will be glad to receive details of any successful device for removing the oil vapor resulting from the lubrication of the air compressor cylinder.

A.—The apparatus used by the large watch companies for purifying the air supplied to rooms in which certain operations are conducted would, perhaps, answer your requirements. The Waltham Watch Co. has been fairly successful in removing lubricating oil from compressed air by passing the air through an after-cooler and settling chamber before it enters the discharge pipes. The after-cooler breaks the air up into small columns and the air is cooled to a temperature that causes a large percentage of the oil to be deposited in the bottom of the settling chamber. Further refinement is accomplished by the use of oil separators in the air mains provided with suitable drip connections. It is necessary to cool the air, and to reduce its travel to a low velocity in the settling chamber in order to remove the oil efficiently.

STRESSES IN SHEAR FRAME

W. W. McK.—I wish to build a small hydraulic shear and would like to have some information regarding the forces acting on and in the frame. Referring to Fig. 8, there is a driving force of 40,000 pounds acting at *A*. When the plate or bar to be sheared is held perpendicular to the line of action of the driving force *A*, what will be the force tending to separate the shear blades; *i. e.*, what will be the amount in pounds or in terms of the driving force *A* of the forces at *B* and *C*? I would also like to know what the angle θ in degrees should be between the top and bottom shear blades in order to offer the least possible resistance to shearing.

Answered by William L. Cathcart

The angle between the blades, that is, the inclination of the upper blade to the horizontal, varies between 5 and 15 degrees — 5 degrees for thin, and 15 degrees for thick material.

General Methods of Determining Stresses

In finding the principal stresses in this shear, the methods of graphic statics will be used, since, in this case, they will be simpler and more compact than analytical treatment. The leading principles on which these methods are based are as follows: To every action there is an equal and opposite reaction. Thus, if an anvil be struck by a hammer, it will strike back with a reacting force equal to the force of the hammer blow. When two bodies strike each other or are pressed together, the reaction of the body struck or pressed upon is, disregarding friction, always normal to the surfaces in contact. A body in motion may be considered as in momentary equilibrium at any instant under the action of the forces and reactions acting upon it at that instant. In order that a body shall be in equilibrium, the lines of action of its forces and reactions must meet in some common point; if they do not thus meet, there is a resultant couple tending to make the body rotate. The particulars required to be known as to each force or reaction of any given system are its magnitude and direction. When all but two of these particulars are known for the system, a "force triangle" or—for more than three forces or reactions—a "force polygon" can be drawn, with each of its sides parallel to the line of action of a corresponding force or reaction. From such a triangle or polygon the unknown magnitudes or directions can be determined. In order that a body shall be in equilibrium, there are two conditions: the force triangle or polygon must close, that is, its sides must meet; and, second, the forces and reactions must all have the same direction in passing around the periphery of the triangle or polygon. When, on the other hand, the direction of any one force in such a triangle or polygon is opposed to that of all of the others, the corresponding side represents, in magnitude and direction, the resultant of a system acting on a body which is not in equilibrium.

Negligible Factors

There are some factors in this problem which, for all practical purposes, may be disregarded, since they have no very material effect on the results, and their omission will greatly simplify the analysis. For example, friction will not be considered although, acting near the upper left-hand corner of the tilted moving blade, it has a relatively slight effect in opposing and reducing the driving force. Again, the cutting edges of the blades are usually ground to an angle of about

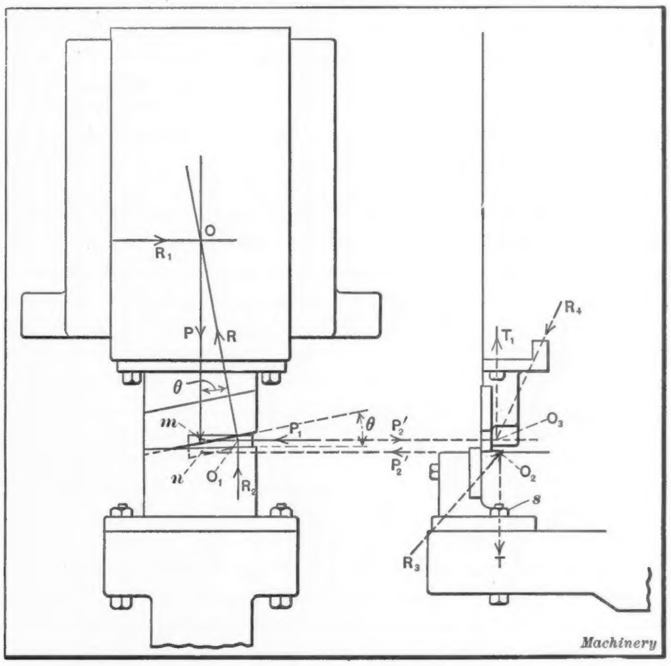


Fig. 1. Diagram showing Forces and Reactions to be considered

87 degrees, that is, 3 degrees with the horizontal, which diverts the effective shearing force and blade reactions into a plane 3 degrees from the vertical. This inclination is too small for consideration in this machine and the shearing faces of the blades will, therefore, be taken as horizontal. Again, the upper blade, after shearing the plate, bends it as the blade moves downward, which reduces the gross driving force by the amount required for bending—a factor which may be neglected. Finally, in finding the reactions of the guide and the lower blade, these reactions and the driving force will be temporarily taken in Fig. 1 as in the same vertical plane, an assumption which will not modify the results appreciably.

Effective Shearing Force and Thrust on Guide

The effective shearing force is the component of the driving force which is normal to the cutting face of the upper blade. The thrust on the guide is the horizontal component of the driving force. Referring to Fig. 1, the driving force is uniformly distributed over the cutting face of the upper blade and the resultant of these distributed forces is a single, concentrated force *P*, having a vertical line of action at the middle of the blade. The upper reactions of the plate or bar which is being sheared have a resultant *R* which is normal to the cutting face of the blade. Similarly, the reactions of the guide against the thrust of the blade have a resultant R_1 which, disregarding friction, is normal to the surfaces in contact and is therefore horizontal. At any point in its stroke the upper blade may be taken as in momentary equilibrium under the action of *P*, *R*, and R_1. While the position of the line of action of *P* is fixed, the positions—although not the inclinations—of the lines of action of *R* and R_1 vary with the position of the blade and that of the bar under shear. As the blade is in equilibrium, the

three lines of action must meet in a common point. Assume that point to be O for this position of the blade and bar.

The driving force is given as 40,000 pounds. In Fig. 2 lay off ab parallel to the line of action of P and equal, to any convenient scale, to 40,000 pounds. From b, draw bc and from a lay off ac, parallel, respectively, to the lines of action of R and R_1. Then, measured on the same scale, $bc = R$ and $ca = R_1$. The directions of P, R, and R_1, as transferred from Fig. 1, are the same in passing around the triangle abc, and hence the blade is in equilibrium. The effective shearing force is equal to R but opposite in direction. Similarly, the thrust on the guide is equal and opposed to R_1. If friction had been considered, R_1 would have been inclined upward from the horizontal by the amount of the angle of friction and the thrust on the guide would have a downward component. In Fig. 1, let θ be the angle between the blades. Then, in Fig. 2, the angle abc is also, by geometry, equal to θ. Hence, analytically, we have:

$$\text{Cos } \theta = \frac{ab}{cb} = \frac{P}{cb}.$$

$$\text{Effective shearing force} = cb = \frac{P}{\cos\theta}.$$

This force is greater than P, as it is distributed over the inclined shearing face of the blade. Similarly:

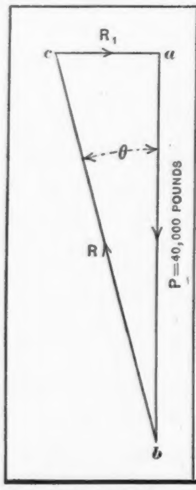


Fig. 2. Force Triangle for Reaction of Upper Blade

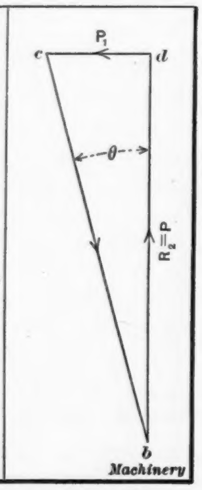


Fig. 3. Force Triangle for Reaction of Lower Blade

$$\text{Sin } \theta = \frac{ac}{cb} = \frac{ac\cos\theta}{P}.$$

$$\text{Thrust on guide} = ac = \frac{P\sin\theta}{\cos\theta} = P\tan\theta.$$

Reaction of Lower Blade

Referring again to Fig. 1 and assuming, as previously stated, that the lines of action of the forces and reactions of the blades all lie in the same vertical plane, the bar which is being sheared is in equilibrium under the action of the effective shearing force, which is the reaction R reversed; the reaction R_2 from the lower blade, which is normal to the surfaces in contact and therefore vertical; and a force P_1 which is equivalent to the effect of friction and acts horizontally toward the left. If there were no friction and if this force were absent, the bar would slide out of the shear toward the right as soon as the upper blade put pressure on it. Since the bar is in equilibrium, these three lines of action meet at the common point O_1.

In Fig. 3, lay off to any convenient scale, cb equal to the effective shearing force and parallel to its line of action. From b, draw bd and from c lay off cd, parallel, respectively, to the lines of action of R_2 and P_1. Then, measured on the same scale, $bd = R_2$ and $dc = P_1$. The angle $cbd = \theta$ and as:

$$cb = \frac{P}{\cos\theta}$$

$$\text{Cos } cbd = \cos\theta = \frac{bd}{cb} = \frac{R_2\cos\theta}{P}.$$

$$\text{Reaction of lower blade} = R_2 = \frac{P\cos\theta}{\cos\theta} = P.$$

Tilting Couple acting to Force Blades Apart

Fig. 4 shows a vertical section of the blades and bar being sheared, the section being taken just to the right of the middle of the blades in Fig. 1. Shearing is not a cutting or sawing action, but a detrusion—a bodily thrusting down by the upper blade of the metal along the plane of shear. The effective shearing force, $\frac{P}{\cos\theta}$, is normal to the cutting edge of the inclined upper blade; it has a vertical component equal to the driving force P, which component is opposed by the reaction from the lower blade, and, as has been shown, this reaction is also equal to P. As the cutting edges are ground to an angle of but 3 degrees with the horizontal, there is no tendency to tip the bar when the upper blade first strikes it, since the pressure of the latter and the reaction of the lower blade have practically the same line of action; but, as soon as the cutting faces of the blades engage the bar fully, the lines of action of the force and reaction move to the centers of their respective blades, and, as shown in Fig. 4, are then distant by an amount x which depends on the thickness of the blades. The two equal and opposite forces P, whose lines of action are separated by the distance x, constitute a couple

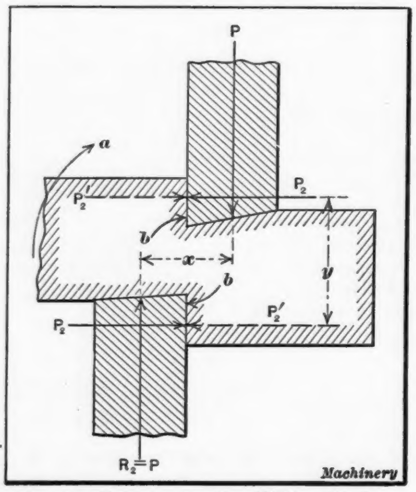


Fig. 4. Diagram showing Tilting Couple and Couple resisting Tilting

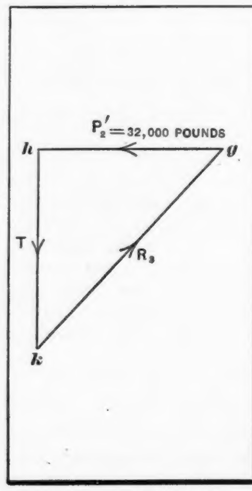


Fig. 5. Force Triangle for Forces and Reaction of Lower Bracket

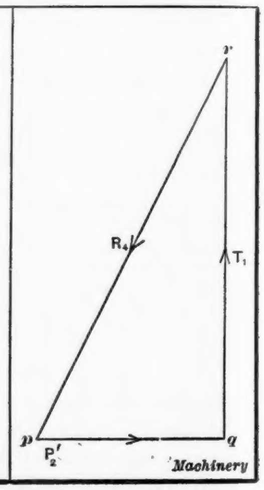


Fig. 6. Force Triangle for Forces and Reaction of Upper Bracket

whose moment or power is equal to the product of one of the forces and the arm of the couple, that is:

Moment of tilting couple $= Px$ inch-pounds.

The tendency of a couple is always to produce rotation of the body on which it acts. As shown by the arrowhead a, this couple, if unopposed, would revolve the bar in a clockwise direction and press it against the blades, tending to force them apart as indicated by the arrows b.

It should be observed that this tilting moment Px is a theoretical maximum which will not be fully attained in practice. It disregards the friction of the upper blade in its guide and assumes that the bar being sheared is thick enough and wide enough to require the full driving force to shear it and to bend the sheared part under the upper blade, as shown in Fig. 1. Further, while the common theory of flexure assumes the shearing stress to be uniformly distributed over the cross-section of a bar under shear, the actual power required to shear such a bar varies at different points in the depth. Thus, Prof. Goodman, in "Mechanics Applied to Engineering," page 315, states that, from autographic shearing diagrams it is found that the maximum force required occurs when the shearing "tackle" is about one-fifth of the way through the bar. At this point then the tilting couple would be a maximum. As, at all other points in the depth of the bar, it would be less, and as the inclination of the upper blade makes every point of its cutting edge shear simultaneously at a different depth, it is wholly probable that the average tilting moment at any point in its stroke is considerably less than the theoretical maximum calculated above—how much less is, however, indeterminate theoretically.

The Couple Resisting Tilting

As has been stated, the couple Px tends to rotate the bar. Since the bar does not thus rotate, this couple must be opposed and balanced. A couple can only be balanced by an opposite couple of equal moment. This resisting couple must be constituted by the reactions of the blades to the pressure upon them by the bar, owing to its attempted rotation by the tilting couple. In other words, the blades make fulcrums of their supports to withstand the strain produced by their own action in different vertical planes, as is essential in

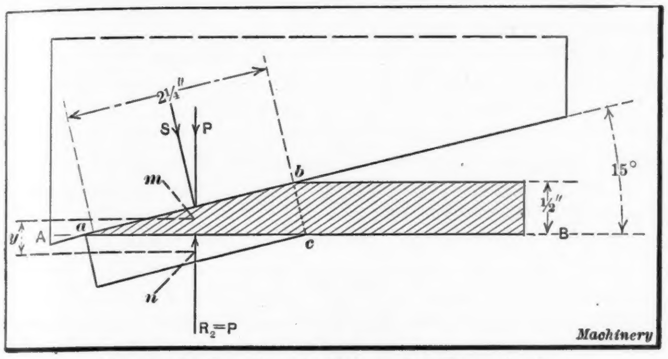


Fig. 7. Section through Plate under Shear showing Average Value of Arm y of Resisting Couple

shearing. The resisting couple is represented in Fig. 4 by the forces P_2 with the arm y, which arm decreases as the blade moves downward. In accepting the theoretical maximum of the tilting couple as above, we shall err on the side of safety. To balance each other, the moments of the two couples must be equal. Therefore:

Moment of resisting couple $= P_2y = Px$ inch-pounds.

It is evident that, so far as tilting is concerned, the couple Px may be replaced by the equivalent couple P'_2y, having the same line of action as the resisting couple P_2y. Then:

Moment of equivalent tilting couple $= P'_2y = Px$ inch-pounds, in which $P'_2 = P_2$.

From this equation, the normal pressure acting near the extremity of each blade to force the blades apart is:

$$\text{Normal tilting force} = P'_2 = \frac{Px}{y} \text{ pounds.}$$

Numerical Results

Substituting in the several equations deduced above, we have the numerical results given in the table. These results apply strictly only when the bar to be sheared is so thick and wide that the total driving force of 40,000 pounds is required to split it. The data for a blade angle of 5 degrees can be found similarly from these equations, if the driving force P be given a suitable value for this metal. In any case, average values of the tilting couple and normal pressure should be estimated from the maximum values tabulated.

TABLE OF SUMMARY OF RESULTS

Blade Angle $\theta = 15°$: Driving Force $P = 40{,}000$ pounds.

Natural functions of 15°: sin = 0.259; cos = 0.966; tan = 0.268.

$$\text{Effective shearing force} = \frac{40{,}000}{0.966} = 41{,}408 \text{ pounds.}$$

Horizontal thrust on guide $= 40{,}000 \times 0.268 = 10{,}720$ pounds.

Reaction of lower blade $= 40{,}000$ pounds.

Maximum moment of tilting couple $= 40{,}000 \times x$ inch-pounds.

Maximum normal tilting pressure on each blade $= 40{,}000 \times \dfrac{x}{y}$ pounds.

Stresses in Holding Bolts of Jaw

The stresses in the bolts holding the jaw, due to the tilting forces on the blades, can be ascertained with accuracy by the methods of graphical statics, when a drawing made to a fairly large scale is available. The results given below—found from a cut no larger than Fig. 1—are necessarily somewhat approximate. The methods of obtaining them, however, can be made entirely clear, and will serve for later application to a suitable drawing. Each of the two brackets of the jaw should be considered separately and regarded as in equilibrium under the action of the forces and reactions acting upon it. The lower bracket is of the same height throughout; the upper bracket, however, slants downward and is deepest at the left, giving the normal pressure a greater leverage there. The force P'_2 represents the total tilting force on each blade, and, while it is distributed along the part of the edge which is cutting it may be considered as concentrated at any selected point where the resultant of its distributed forces may be assumed to act. This force should be given a definite value, in order to find the stresses in the bolts. Assume that a narrow bar of ½-inch steel is to be sheared, and that it will be inserted at about the center line of the blades, as shown in Fig. 1. Take $x = 3/8$ inch and $y = 3/8$ inch as an average value when the maximum resistance to shearing occurs; and estimate four-fifths of the maximum tilting pressure as the average normal pressure along the cut at this time. Then, from the table:

Normal tilting pressure $P'_2 = 4/5 \times 40{,}000 \times 3/8 \times 8/3 = 32{,}000$ pounds.

Now, assume the forces P'_2 as acting at the points m and n near the center lines of the blades. Consider the lower bracket of the jaw; as the force P'_2 is regarded as concentrated at the point n, we may take the total tensile stresses in the two bolts as temporarily concentrated in a single bolt s, which alone secures the flange and is in the vertical plane passing through the points m and n. The bracket is, therefore, in equilibrium under the action of the force P'_2, acting toward the left; the tensile stress T in the bolt, acting downward; and a reaction R_3 from the frame. From n project the line of action P'_2 on the side elevation of the bracket and draw through the center of the bolt the vertical line representing the line of action of T. These two lines of action meet at the point O_2. Under the thrust of the force P'_2, the bracket will tend to tip, pivoting on the lower, left-hand corner. This corner gives one point in the line of action of R_3; the other point is determined by the fact that, for equilibrium, the lines of action of all forces and reactions must meet at a common point, which is the point O_2. The line of action of R_3 therefore passes through O_2 and the lower, left-hand corner of the bracket and is so drawn in Fig. 1.

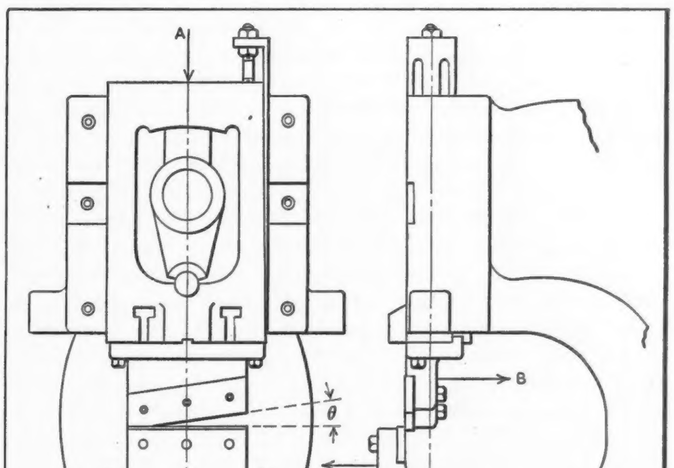


Fig. 8. Type of Shear to be designed

In Fig. 5—which should be drawn to as large a scale as possible—lay off gh parallel to the line of action of P'_2 in Fig. 1 and equal to 32,000 pounds. From g and h, draw gk and hk parallel, respectively, to the lines of action of R_3 and T, as given in Fig. 1. Then, measured on the same scale, the total tensile stress T will be found to be 34,130 pounds. As there are two bolts, the stress in each will be 17,065 pounds, since the points m and n are on the center lines of the blades. If the bolts are made small enough to stretch to an appreciable extent when under strain, tensile bending stress will also occur in them. With moderately large, body-bound bolts, the effect of bending may be disregarded.

Fig. 6 shows the force triangle for the upper bracket. It is drawn similarly. The line of action of P'_2 in Fig. 1, projected from the point m, meets the line of action of the upward tensile stress T_1 in the bolt at the point O_3. The bracket pivots on its upper right-hand corner. The line of action of the reaction R_4 passes through this corner and the point O_3. The bracket is in equilibrium under the action of P'_2, T_1, and R_4. In Fig. 6, the line pq is drawn parallel to the line of action of P'_2 and equal, as before, to 32,000 pounds. From q and p, the lines qr and pr are laid off parallel, respectively, to the lines of action of T_1 and R_4, as given in Fig. 1. Then, measuring on the same scale, we have $qr = T_1 = 64{,}000$ pounds or 32,000 pounds in each of the two bolts. As in Fig. 5, the direction of the reaction R_4 is determined by the condition that, in passing around the triangle, all forces and reactions must have the same direction.

The greater tensile stress in the upper bolts, as compared with that in the lower, is due to two conditions: first, the distance from the point m to the flange above it is slightly greater than the corresponding distance from the point n to the lower flange, giving the pressure on the upper blade a greater leverage; and, second, according to the cut, the base of the upper bracket is narrower than that of the lower, which makes the inclination of the line of action of its reaction more nearly vertical than that of the lower bracket. It should be remembered, as to these results, that they are neither exact nor closely approximate, owing, first, to the necessary assumptions as to the average magnitude and location of the resultants of the normal tilting forces on the blades, and, second, to the small scale of the drawing from which the directions of the reactions were found. The method of obtaining them has, however, been made sufficiently clear to enable more accurate results to be obtained under suitable conditions.

In any event, the values of the resisting couple and the normal pressures on the blades will vary with any differences in the thickness and shearing strength of the plate to be sheared. The maximum possible values should, of course, be used in designing. Thus, if the driving force P be taken as 40,000 pounds and the ultimate shearing strength of steel as 70,000 pounds per square inch, then $\frac{40{,}000}{70{,}000} = 0.57$ square inches, the greatest possible area of the triangular section abc under shear in Fig. 7. This gives a thickness of plate of 1/2 inch, a length ab of 2 1/4 inches, and an average value of y of about 0.35 inch, or slightly less than 3/8 inch. It will be seen that the points m and n and the locations of the forces P and R_2 move to the right as the blade descends. Hence, if plates of nearly the full width of the blades are to be sheared, the total normal pressure on either blade cannot be considered as equally divided between the two holding bolts, but must be taken as applied at some points as near relatively to each bolt as is shown for the left-hand bolt in Fig. 7, which is drawn approximately to scale. In this figure, AB represents the top of the lower blade and S the effective shearing force which has been made equal to P to allow roughly for friction and bending. The force P'_2 should be taken as near as practicable to either bolt and then divided between the two bolts, inversely as their distances from it. Thus, if P'_2 acts three times as far from one bolt as from the other, the latter will have a maximum strain of $\frac{3}{4} P'_2$.

* * *

GENERAL TREND OF AMERICAN MOTOR DESIGN

In a paper presented by W. M. Power before the Metropolitan Section of the Society of Automobile Engineers in New York City March 26, 1914, a comparison was made between the general developments of American and British motors. American motors, with few exceptions, are characterized by large cylinders, the ratio of bore to stroke, compression, piston speed, maximum output per pound, and economy being low. The British automobile makers have gone to the other extreme and are building motors having almost exactly opposite characteristics, from which they are getting power outputs which, a few years ago, would have been considered impossible. The fuel economy of these engines is far beyond anything obtained by American makers. These results are due to very large valves and ports, the latter being designed to give smooth flow lines. High compression and very high piston speeds, well above 3000 feet per minute, are characteristic of these motors; but these engines must be driven carefully if they are to give maximum service. The motor must never be allowed to run on wide open throttle at low speeds. This means, of course, that gear changing is frequently necessary. These engines require great care in driving and adjustment, and the overhauling must be carefully done.

The British and American types of motors have advantages peculiar to themselves both from the manufacturing and operating standpoint. Given proper equipment in the shop, the workmanship required in the two types is about the same, except that the light connecting-rods and pistons required for the small motor are somewhat more costly and more difficult to manufacture.

The probability is that the most suitable motor for service in America is a compromise between the extreme British type and the present American type, being designed to give a well sustained torque up to about 2000 feet piston speeds per minute. The capacity of an engine for a five-passenger car should probably be about 4000 to 4500 cubic centimeters for a four-cylinder motor and about 5500 to 6000 cubic centimeters for a six-cylinder car.

* * *

WORLD'S OUTPUT OF IRON AND STEEL

The probable world's output of iron ore in 1912 was about 152,000,000 tons, or more than 5 per cent above that of 1910. The principal producers were the United States, Germany, France, the United Kingdom and Spain, in the order given, these five countries producing about six-sevenths of the total output of the world. The following table gives the output of iron ore in 1911 and 1912:

	1911, Tons	1912, Tons
United States	43,877,000	55,150,000
Germany (including Luxemburg)	29,399,000	32,190,000
France	16,372,000	18,744,000
United Kingdom	15,519,000	13,790,000
Spain	8,633,000	———
Russia (excluding Finland)	6,882,000	8,054,000
Sweden	6,055,000	6,593,000
Austria-Hungary	4,640,000	2,880,000
Canada	188,000	156,000
Belgium	148,000	165,000

The ore resources of the world are given in an estimate made at the International Geographical Congress at Stockholm in 1910. It was then estimated that the total actual resources of iron ore existing in deposits that can at present be worked at an economic profit amount to 22,408,000,000 tons, representing 10,192,000,000 tons of iron. This total would supply the requirements of the world for considerably less than two centuries, even were the present rate of output not exceeded. The actual resources of the principal ore-producing countries are estimated to be, in the United States 4,258,000,000 tons, the equivalent in metallic iron being 2,305,000,000 tons; in Germany and Luxemburg, 3,878,000,000 tons, estimated to yield 1,360,000,000 tons of metallic iron; in the United Kingdom 1,300,000,000 tons, equal to 455,000,000 tons of metal; in France 3,300,000,000 tons, equal to 1,140,000,000 tons of metal; and in Spain 711,000,000 tons, equal to 349,000,000 tons of metal. In addition, the potential resources of the world not yet developed are estimated, so far as they can be calculated in figures, to amount to 123,377,000,000 tons of ore, representing 53,136,000,000 tons of iron. Further, very large supplies of iron ore are understood to exist in China, Canada, and other countries.

The world's production of pig iron in 1912 was about 72,000,000 tons, the United States, Germany, and the United Kingdom accounting for about seven-ninths of the total. The United States' output was 29,727,000 tons; Germany's, 17,582,000 tons; and the United Kingdom's, 8,751,000 tons. For the first half year of 1913 the figures for the three principal countries were: United States, 16,489,000 tons; Germany, 9,414,000 tons; United Kingdom, 5,411,000 tons.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

UNION FORMED CUTTER GRINDER

The grinding machine which forms the subject of this article has been developed by the Union Twist Drill Co., Athol, Mass., for use in sharpening gear-cutters and similar types of formed cutters. Its use enables the cutting face of the teeth to be ground radial, with the periphery of each tooth at the same distance from the center of the cutter. The grinding wheel is mounted on the lower end of the vertical spindle, the spindle being carried by a slide which has a vertical movement to provide for advancing the wheel to the cut. The spindle may also be moved in a plane at right angles to its axis to suit the diameter of the cutter to be ground. The cutter is mounted on a horizontal arbor sup-

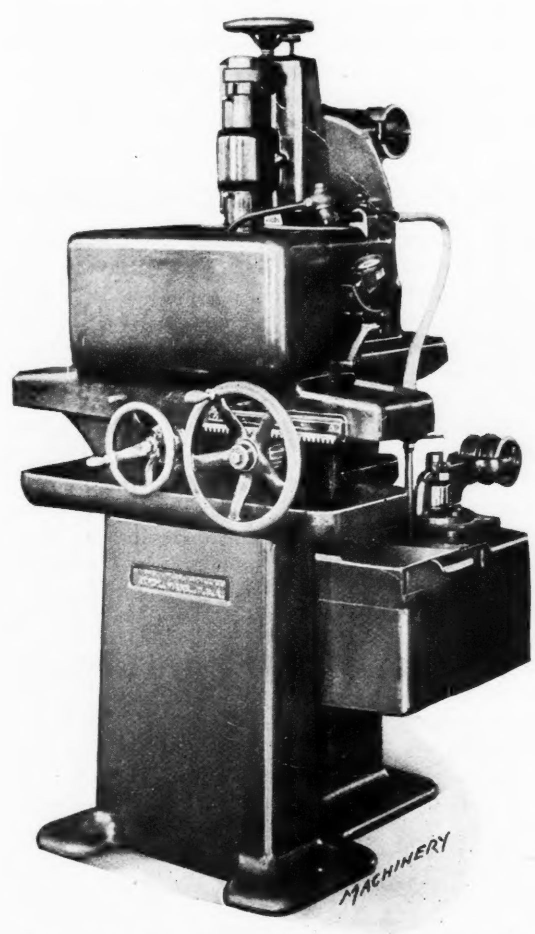


Fig. 1. Union Twist Drill Co.'s No. 2 Formed Cutter Grinder

ported by the table. The capacity of the machine is for cutters up to 8 inches in diameter by 3 inches face width, and the size of the grinding wheel used is 6 inches in diameter, with an adjustment of 4 inches to or from the work in a horizontal plane.

A pump and tank provide an ample flow of water to the grinding wheel and the spray thrown off by the wheel is caught by the walls of the tank in which the cutter and wheel are located. In the operation of sharpening the cutter, the table carrying the cutter is moved back and forth past the grinding wheel. An extra movement of the table toward the right carries a diamond across the face of the grinding wheel. This diamond serves two purposes. First, it may be used to remove glaze and true the face of the wheel; second, it acts as a stop for the vertical adjustment of the wheel when sharpening each tooth of the cutter. The diamond is located in the horizontal plane passing through the center of the cutter arbor by means of a gage provided for the purpose. When the wheel slide has been adjusted downward until the wheel makes contact with the diamond, the cutting

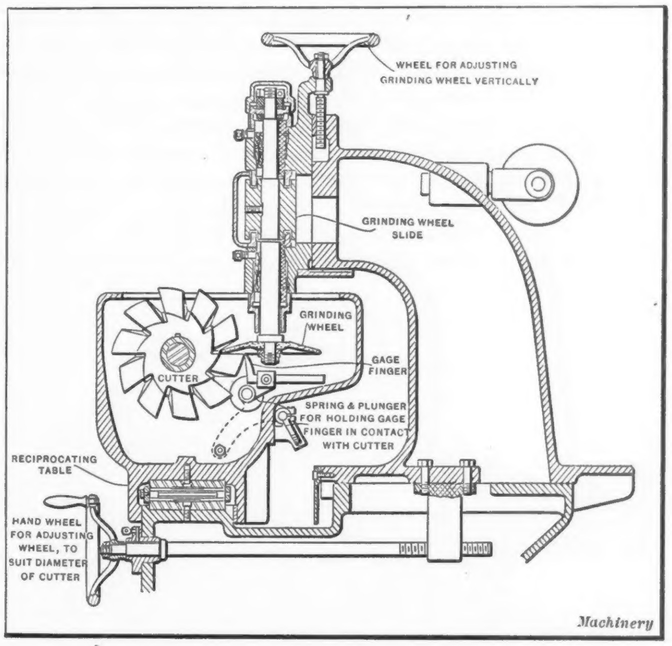


Fig. 2. Cross-section through Grinder showing the Gage Finger for measuring the Peripheral Eccentricity

face of the wheel must be in the same plane as the center of the cutter, and the face of the teeth of the cutter ground with the wheel in this position must be truly radial.

For indexing the teeth of the cutter when grinding, a patented principle is employed. In explanation it may be remarked that if an evenly spaced index plate is used for locating each tooth of a cutter relative to the grinding wheel, the cutter may not run true, *i. e.*, the periphery of each tooth need not be at the same exact distance from the center of the cutter. This is due to the change of form which frequently takes place when the cutter is hardened. When hardened, the cutter will have a tendency to assume an elliptical shape, in which event it will not run true when the teeth have been evenly spaced. The eccentricity of the different teeth of the cutter suggests a way of correcting this error resulting from the hardening operation. By gaging each tooth, it is possible to determine which teeth are farthest from the center, and by grinding these teeth on their radial face, the distance of the periphery of each tooth from the center can be made the same. The design of the Union Twist Drill Co.'s No. 2 cutter grinder is such that the amount ground off the radial face of each tooth is proportional to the distance of the periphery of that tooth from the center of the cutter.

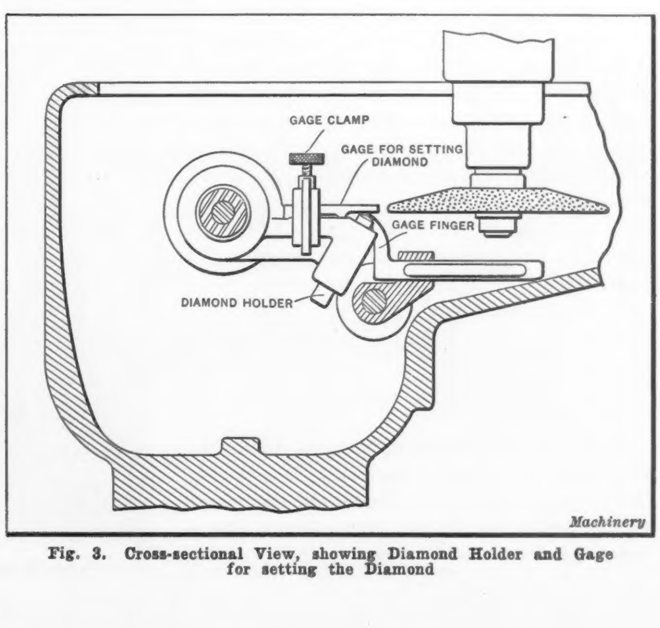


Fig. 3. Cross-sectional View, showing Diamond Holder and Gage for setting the Diamond

After the cutter is correctly ground, it may be that the teeth will not be accurately spaced but the cutter will run very true. This result is obtained by means of a gage finger shown in Fig. 2, which is adjusted to engage with the relieved periphery of a tooth of the cutter at a point near the radial face of the tooth. The gage is held in contact with the cutter by a spring and the exact location of the point of the gage relative to the center of the cutter is indicated on a dial. A movable pointer on this dial is actuated through a system of multiplying levers so that a variation in position of the gage finger of 0.001 inch may be easily read. This gage is virtually a radius caliper. By applying the finger of the gage to each successive tooth of the cutter, and rotating the cutter on its axis until the reading of the pointer on the dial is the same for each tooth, the particular point in the periphery which is at the same distance from the center may be determined. It now only remains to grind the radial face of each tooth with exact reference to the gage finger to insure the truth of the cutter.

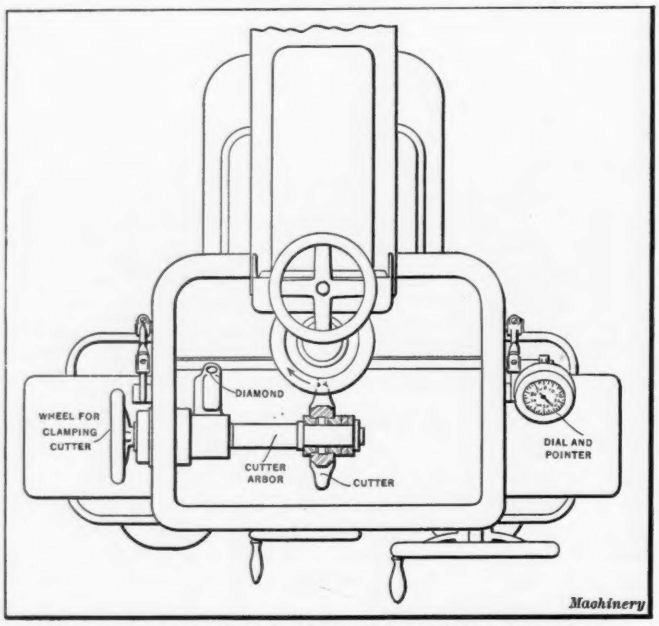
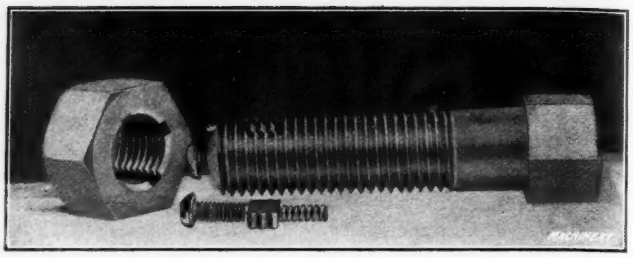


Fig. 4. Arrangement of the Cutter Arbor and Dial of the Gage for testing the Work

SCHUM LOCK-NUT

A lock-nut of somewhat unusual design, which is illustrated herewith, is a recent product of Schum Bros., Metropolitan Tower, New York City. Referring to the illustration it will be seen that a bolt and nut arranged for this system of locking are shown, and also a binding screw and locking key which have been removed from the bolt in order to illustrate the principle of operation. The nut to be locked has four slots broached in it, two of these slots being clearly shown. A hole is drilled into the end of the bolt and a small compression spring fits into the bottom of this hole, while the upper part of the hole is tapped to receive the binding screw. It will also be seen that a transverse slot is cut through the bolt and the ends of a key which fits loosely in this slot are threaded to correspond with the threads on the bolt. When the screw is turned down, this key is pushed to the right so that the threads are brought into alignment with the threads on the bolt. Under these conditions the nut can be screwed onto the bolt in the usual way.

When the nut has been screwed down into place and it is desired to lock it in position, it is merely necessary to loosen the small screw in the end of the bolt. When this is done the compression spring pushes the key toward the left (as the bolt appears in the illustration). Should the nut start to loosen, it can only turn far enough to bring the key into the first slot in the nut. When this point is reached, the spring will push the key up so that the threads are out of alignment with the threads on the bolt. In this way the key is held in one of the slots in the nut and cannot enter the threads on the opposite side of the slot to enable the nut to turn any farther. As there are four slots in the nut it is obvious that the maximum distance through which the nut can turn before being positively locked is one-fourth revolution. When it is desired to remove the nut it is merely necessary to tighten the adjusting screw, thus forcing the key down into alignment with the threads on the bolt to enable the nut to be turned off in the usual way.

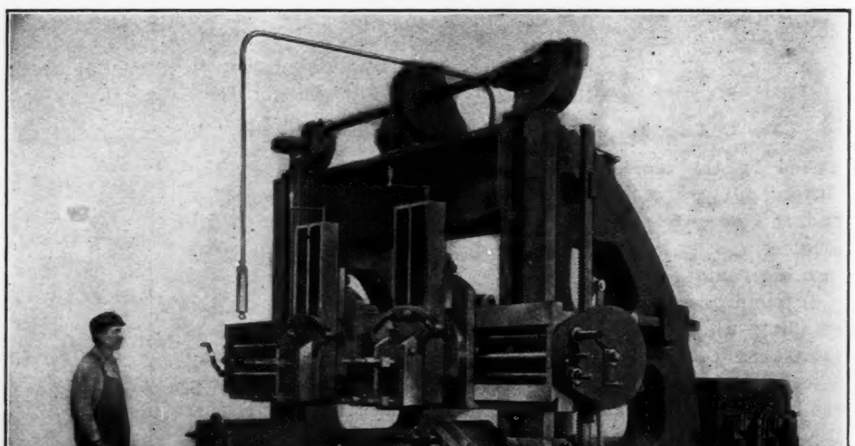


Schum Lock-nut

NILES-BEMENT-POND PLANERS

Heavy-duty planers with capacities of 120 by 72 inches, 96 by 72 inches and 86 by 48 inches have recently been built by the Niles-Bement-Pond Co., 111 Broadway, New York City, for use in the plant of the Commonwealth Steel Co., of St. Louis, Mo. All of these machines have capacities for planing work up to 18 feet long and they are all equipped with two heads on the cross-rail and a side head on each of the housings. These planers were constructed for very severe work on steel castings, and to meet the requirements of this service it was necessary for the construction to be worked out along exceptionally heavy lines. All of the gears are made of steel castings or steel forgings, and all of the bearings are bronze bushed and supplied with provision for ample lubrication. All of the shafts are unusually heavy and all wearing surfaces are proportioned for long and accurate service.

The accompanying illustration shows one of the 86 by 48 inch by 18 foot machines. This planer is 88 inches wide between the uprights and takes 50 inches between the table and cross-rail; the table is 80 inches wide by 20 feet long. The drive is from a 50-horsepower reversing motor of the Niles-Bement-Pond Co.'s system, which is direct connected to the



Niles-Bement-Pond 86-inch by 48-inch by 18-foot Planer built for the Commonwealth Steel Co.

gearing. The speed of the table may be instantly adjusted by handwheels which are conveniently located on the controller, without requiring the planer to be stopped. The speed range is from 25 to 50 feet per minute for the cutting stroke and from 50 to 90 feet per minute for the return stroke. The driving motor is direct-connected to the first driving shaft at the back of the planer, and the controller, resistance, pilot switch and circuit breaker are mounted in a ventilated cabinet which also contains all of the wiring except the wires from the controller to the motor, which are carried across the planer bed in a metal conduit.

Operating levers on the front and back of the bed are connected to the reversing switch and may be operated by hand or automatically by means of adjustable dogs on the table. At the instant of reversal, the motor—through proper connections in the controller—is disconnected from the line and becomes a powerful dynamic brake, stopping the table at once without taking current from the line. A patented pendant switch, carried by a swiveling bracket mounted on the arch, may be moved by the operator to any convenient position and gives him control of the driving motor for starting, stopping or reversing the table. This switch is particularly convenient in handling work which requires the operator to be in such a position that he cannot reach either of the levers on the front or back of the bed. In order to prevent the table running off the gearing, or damage to the tools or machine caused by failure of the line current or overload, a circuit breaker is provided which will stop the motor at once by dynamic braking. The cross-rail is raised and lowered by an independent reversible motor.

SHUSTER STRAIGHTENING AND CUTTING-OFF MACHINE

The machine for straightening and cutting off round, square or hexagonal bar stock, which is illustrated in Figs. 1 and 2, is a recent product of the F. B. Shuster Co., New Haven, Conn. The design follows the general lines of the No. 6 machine of this company's manufacture which was illustrated and described in the April, 1912, number of MACHINERY. The special feature of the No. 17 machine, which is the subject of the present article, is the provision of independent adjustment for each of the vertical and horizontal straightening rolls. This is obtained by means of universal joints which connect all of the straightening roll shafts and roll gears, giving a wide adjustment of the rolls without changing the gears. This makes it possible to handle round, square or hexagonal stock from 3/8 to 3/4 inch in size with one set of rolls, thus saving the expense of extra rolls and the time consumed in changing. It will, of course, be understood that one set of rolls is only applicable for handling one shape of stock. The rolls are grooved to correspond with the shape of the material which they are intended to handle and the range of the machine is for work from 3/8 to 3/4 inch in size.

The machine consists of a substantial bed, on which a housing is mounted which supports five vertical and five horizontal straightening rolls that are adjusted by means of square-head screws. There is a set of feed rolls at the rear and another set at the front of the machine. A balance wheel, which connects with a train of gears that operates all of the rolls, drives the machine. The method of operation is as follows: the coil of material to be straightened and cut up is placed on a reel at the rear of the machine and the end is carried through guides and passed between the feed rolls. These rolls grip the stock and carry it along through the horizontal and vertical straightening rolls, from which it passes to the front feed rolls and then through the stationary die. After

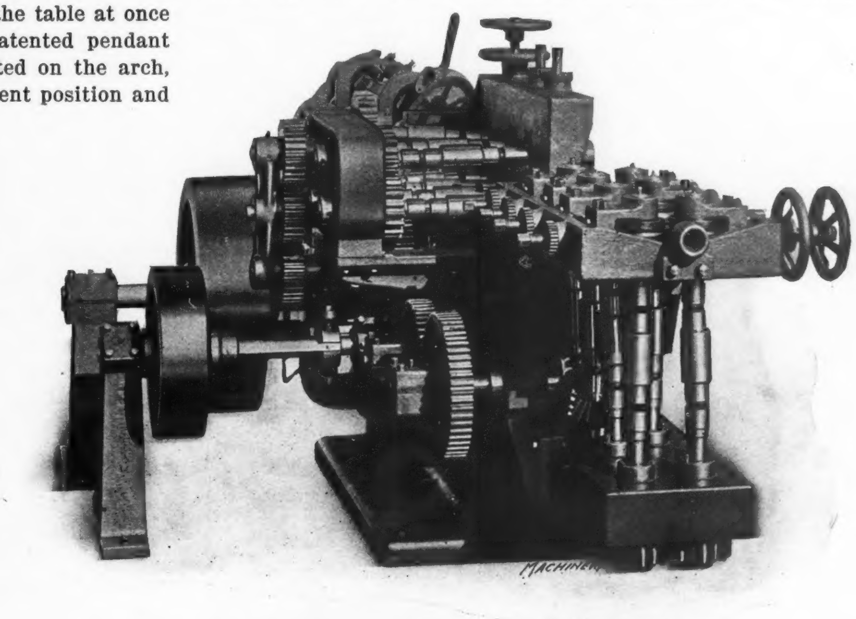


Fig. 2. Rear View of Shuster Straightening and Cutting-off Machine

leaving the die, the stock enters the covered guide bar and moves forward until it strikes a gage which is set for the desired length of pieces that are to be cut off.

When the stock strikes the gage it operates a clutch mechanism which instantly stops the feeding of the stock and operates the cut-off. The cutter severs the piece, after which the cover of the guide bar is raised and the straightened bar drops into the forked holders placed to receive it. The return of the cutter to its starting point sets the feed rolls in motion and another piece is fed through the machine and cut off, the cycle of operations being repeated over and over until all the material on the reel is cut up. The stopping of the feed rolls during the cutting operation prevents any crowding of material against the cutters. The machine shown in the illustrations is arranged to cut off lengths up to 20 feet but

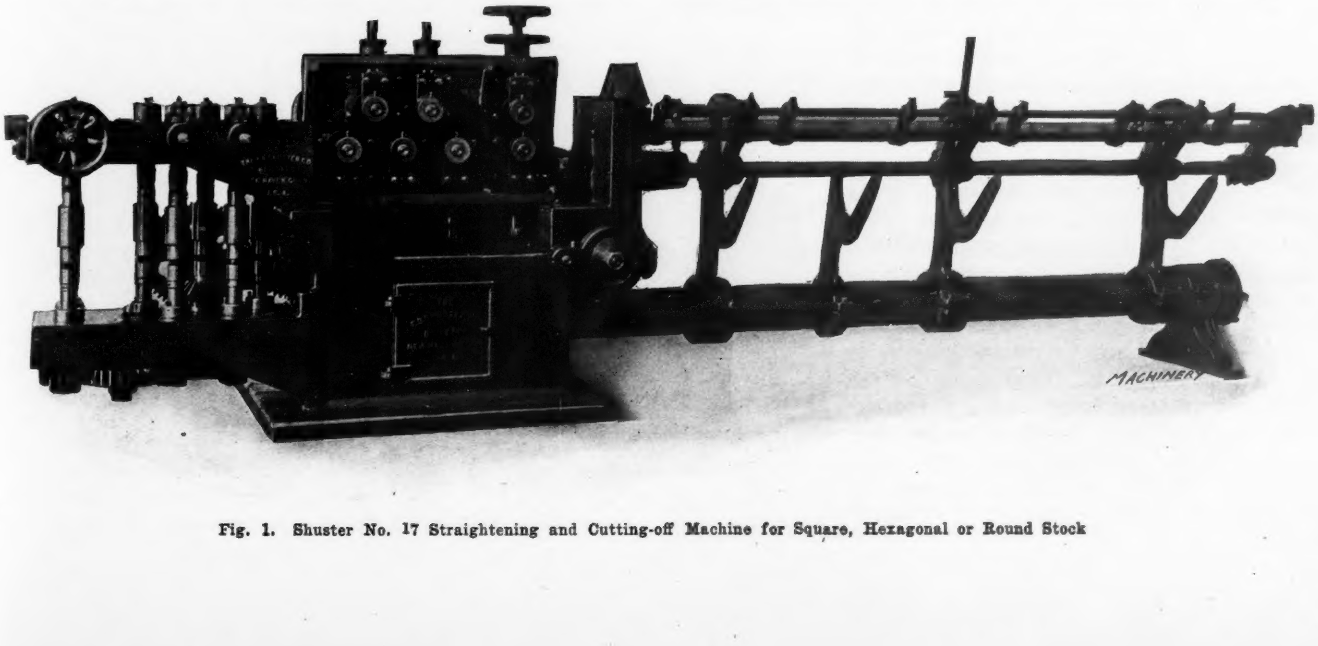


Fig. 1. Shuster No. 17 Straightening and Cutting-off Machine for Square, Hexagonal or Round Stock

only a portion of the extension of the machine is shown. Machines of the same type could be made to cut off longer bars if desired.

SLEEPER & HARTLEY SPRING COILING MACHINE

Sleeper & Hartley, Worcester, Mass., have recently brought out a special spring coiling machine which is made in five sizes. The No. 1 machine which is shown in the accompanying illustration has a capacity for coiling springs of wire ranging from 0.023 to 0.080 inch in diameter. These machines are particularly intended for the rapid production of straight springs in long or short lengths, and of either the extension or compression type. A cutting-off attachment, a diameter varying attachment and adjustable pitch tools can be provided. Either open or close coil springs of straight, conical or barrel shape may be wound. The No. 1 machine will coil springs at an average rate of 200 feet of wire per minute on any size within the capacity of the machine. It will not, however, produce open coil springs having the end coils laid close.

A front view of the machine is shown in Fig. 1, and Fig. 2 illustrates the side of the machine where the cam-shafts are

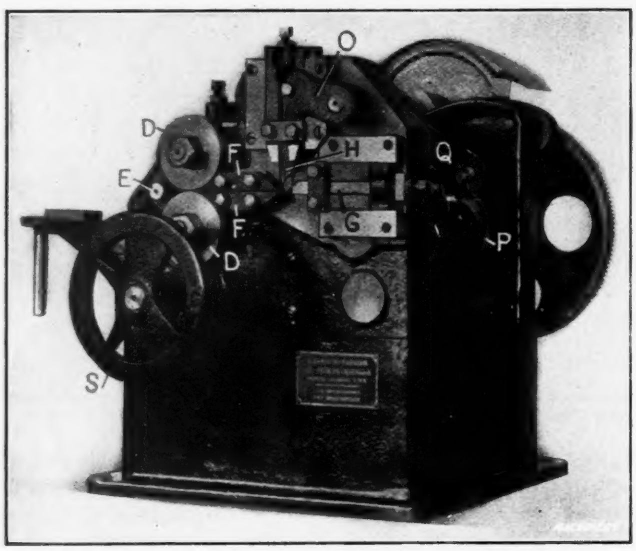


Fig. 1. Front View of Sleeper & Hartley Spring Coiling Machine

located which operate the feed and cut-off mechanisms. Referring to Fig. 2, power is transmitted from the driving pulley *A* to the camshaft, upon which the large gear *B* is mounted. The feed roll shafts are also driven through gearing from pulley *A*; these shafts are almost hidden as they are very nearly in line with two other shafts nearer the front of the machine.

The wire is fed between the feed rolls *D*, Fig. 1. Before being gripped by the feed rolls, it passes through the guide bushing *E* and after passing through the rolls it is fed between the guides *F* and strikes the coiling point or deflector *G*. The point of this deflector may be adjusted so that springs of any required diameter may be coiled. As soon as the required length of coil has been run off, the cutter *H* descends and severs the wire. This cutter is actuated from the shaft *K*, Fig. 2, on which there is a cam *M* that acts on the lever *N*. The lever *N* is located on a short shaft and transmits motion to the lever *O* at the front of the machine. The end of the lever *O* is slotted and fits over a pin in the cut-off slide, the slide being reciprocated through the action of this system of levers and the cam.

While the cutter is operating the wire is at a standstill. This interruption of the wire feed is secured by raising the upper feed roll *D* so that it is out of contact with its mate, thus releasing the wire. This movement of the feed roll is governed by the leaf cam *P* on the shaft *K*. The cam *P* actuates a lever *Q* carried by the shaft *R*. Levers from the shaft *R* extend over the upper feed roll shaft and by means of the cam action, these levers raise or lower the upper feed roll. By means of the three leaf cams, any desired length of feed may be secured. A handwheel *S* provides for trying the machine on any set-up before commencing to operate it under power. This machine is entirely automatic in action, coiling

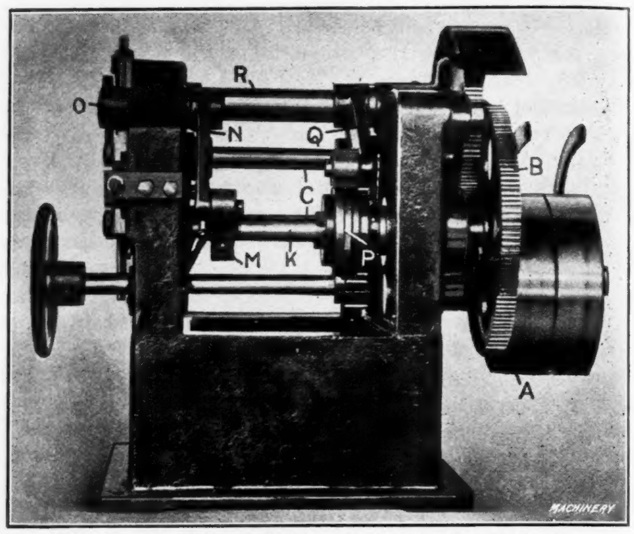


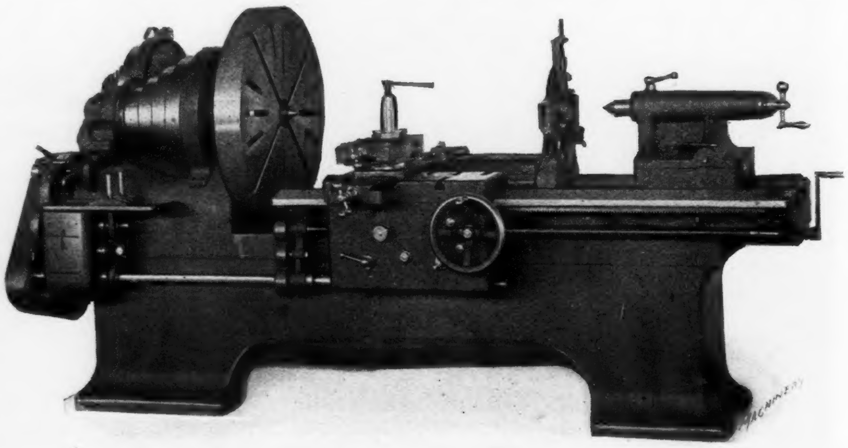
Fig. 2. Side View of Machine showing the Cam-shafts for controlling the Feed and Cut-off

any shape of springs within its range and automatically cutting them off without requiring attention from the operator.

BARNES EXTENSION GAP LATHE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now building the heavy-duty extension gap lathe which is illustrated herewith. This machine swings 22 inches over the bed, 36 inches through the gap and 14 inches over the carriage. It takes 50 inches between centers when closed and 86 inches between centers when extended; the gap opens 36 inches. The ratio of the back gearing is 8 to 1 and of the double back gearing 44 to 1. There are twelve changes of spindle speed ranging from 2.3 to 400 revolutions per minute and six changes of geared feed as follows: 0.008, 0.15, 0.27, 0.39, 0.71 and 0.123 inch per revolution.

The lathe is intended for heavy duty and is of exceptionally rigid construction. The bed is adequately braced and of ample proportions, with the top of the sliding bed 24⅞ inches wide in order to afford strong support for the carriage when the machine is operating on large work through the gap. The spindle is 3 15/16 inches in diameter in the front bearing and has a 2⅛-inch hole through it. The steps of the cone pulley are made of exceptionally large diameter to afford ample power from a 3-inch belt, this plan having been adopted in place of increasing the width of the steps. This enables the headstock to be shorter than would otherwise be the case.



Barnes Double Back Geared Extension Gap Lathe

The diameter of the four steps of the cone pulley are 18, 15, 12 and 9 inches, respectively, by 3⅛ inches wide. The machine will cut from 2 to 20 threads per inch. The regular length of bed furnished with the lathe is 8 feet 6½ inches, and with a bed of this length the approximate weight is 5300 pounds.

Cincinnati Combination Hand Drill and Sensitive Drilling Stand

CINCINNATI SENSITIVE DRILLING STAND

The accompanying illustration shows the combination of a portable electric hand drill and a stand upon which this tool can be mounted. With the hand drill set up in position on the stand, the combination constitutes the equivalent of a sensitive bench drill, while the drill may be removed from the stand and used as a portable tool. The hand drill may be mounted in the stand in a few seconds by means of thumb nuts which secure hinged caps that lock the drill in the bracket. The bracket has a feed of 3 inches on the column and is provided with quick return; the feed is operated by means of a hand lever. The bracket also has a vertical adjustment through the clamping screws on the column and can be set at any desired point. A stop regulates the depth to which the holes are to be drilled.

This sensitive drilling stand is made to receive hand drills of ¼, ⅜ and ½ inch capacities. It weighs 60 pounds. The table is 8 inches in diameter and is adjustable for height; it can be swung to one side to enable the machine to handle work for which the table is not required. The distance from the column to the center of the table is 5 inches and the column is 30 inches high by 1¾ inch diameter. The base of the machine is 9 by 11 inches in size. This combination hand drill and sensitive drilling stand, which is a recent product of the Cincinnati Electrical Tool Co., Cincinnati, Ohio, will be found particularly handy for use in shops where the work includes bench drilling and drilling operations for which a portable tool is required. The stand can be set up anywhere and occupies very little space.

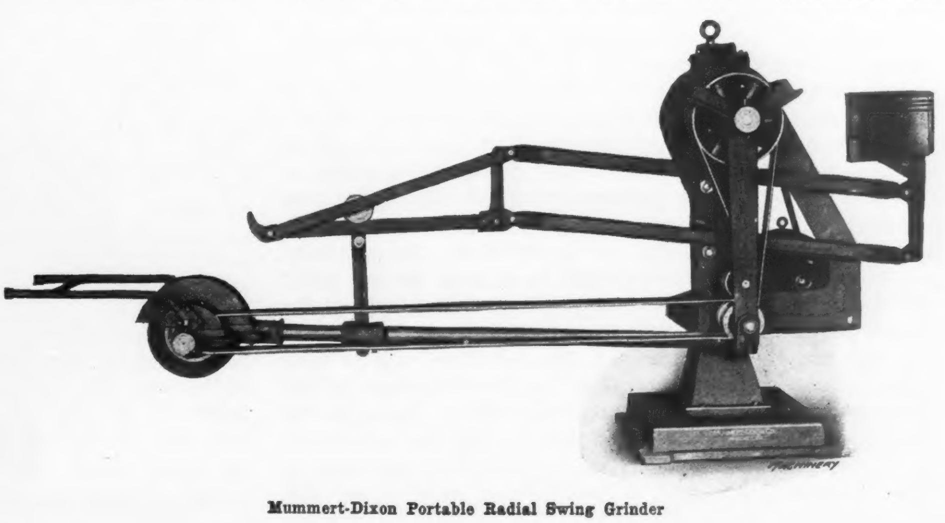
MUMMERT-DIXON RADIAL GRINDER

The Mummert-Dixon Co., Hanover, Pa., has recently added to its line of grinding machines the radial swing grinder which is illustrated herewith. This machine is intended for grinding large and medium size castings and for handling general classes of buffing work. It will be evident from the illustration that the machine is fully self-contained, being driven by a motor mounted on a platform which is part of the main housing of the machine.

The machine is adapted for portable service and requires no preliminary work in setting it up before it is ready for work. This feature enables the grinder to be carried about by a crane, the eye at the top of the pedestal being convenient for receiving the crane hook. This is a complete radial grinder, it being possible to swing the arm carrying the grinding head through a complete revolution. The grinding head and swinging arm are carried back and forth by a roller bearing trolley which runs on a track held in a horizontal position by two parallel arms. The counterweight is placed at the opposite end of these arms. This arrangement of parallel arms or "paradox lever combination," as it is sometimes called, keeps the head perfectly balanced for any position of the trolley on the track and gives a free movement to the swinging arm. The grinding head can be twisted in either direction up to 90 degrees, which is a great convenience in grinding the sides of castings.

The emery wheel is driven by a single belt which is carried around the jointed connection of the swinging arm and hanging swing frame by two self-oiling idler pulleys from which the belt runs to the large pulley at the top of the machine. The upper pulley is driven by a shaft from the driving pulley, which is located on the inside of the housing, the motor being belted to the driving pulley. The machine is mounted on a substantial base which supports a vertical pedestal, and the main frame or housing is mounted on this pedestal, being free to turn on it.

On the side of the housing, there is a bracket which carries the swing frame in which the pulleys are supported. The swinging arm to which the grinding head is attached is joined to the lower end of this frame. The swing frame hangs on two phosphor-bronze bushings which extend through the bracket, these bushings forming the bearing for the main driving pulley. The emery wheel in the grinding head is protected by a hood and the handles attached to the head enable the operator to obtain a good hold and to have full control of the head at all times. The wheel arbor runs



Mummert-Dixon Portable Radial Swing Grinder

in phosphor-bronze bearings with provision for taking up wear. The arbor has safety flanges to protect the wheel and carries a wheel 18 inches in diameter by 3 inches face width.

ROBERTSON NO. 7 POWER SAW

The latest addition to the line of "Economy" power saws built by the W. Robertson Machine & Foundry Co., Buffalo, N. Y., is the No. 7 machine illustrated herewith. This tool has a capacity for work up to 10 by 24 inches in size, and work can be cut at angles up to 45 degrees. In mentioning the capacity of this machine it should be stated that stock as small as ½ inch can be cut very accurately, the range extending from this size up to 10 by 24 inches.

The machine is of heavy construction to adapt it for the large work for which it is intended, and the bearings are of ample proportions and provided with efficient means of lubrication so that the saw operates smoothly and quietly. The cut is taken on the draw stroke and the blade is lifted clear of the work on the return stroke by means of the Robertson dash-pot mechanism. This consists of a plunger which is so timed in relation to the crankshaft of the machine, that it starts to compress oil contained in a cylinder below the bed at the same time that the saw starts on the return or idle stroke. The result is that the blade is lifted clear of the work so that it is not exposed to the wear which would result by dragging it. At the end of the stroke, the pressure in the oil cylinder is released and the saw is let carefully down into contact with the work ready for another cut. This feature has been used for several years on Robertson hacksaws with

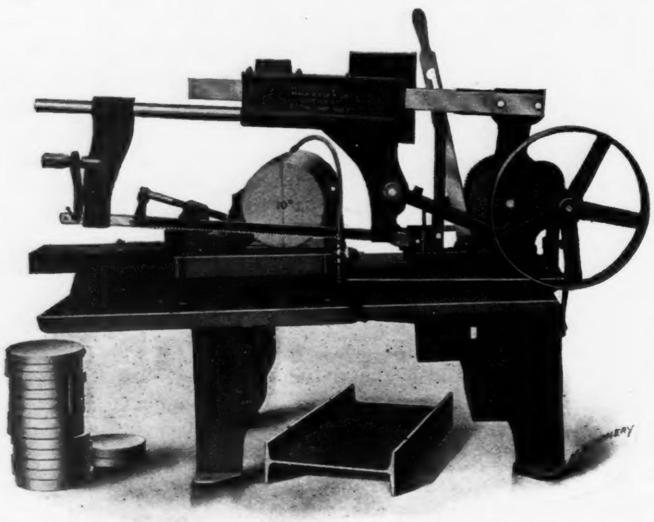


Fig. 1. Robertson No. 7 "Economy" Power Saw

very satisfactory results. Another feature of this machine is the two-speed drive, which was briefly described in the March number of MACHINERY. The arrangement consists of a set of sliding gears by means of which the high speed may be employed for cutting soft steel and the slow speed for cutting tool steel, either speed being obtained by simply pulling out or pushing in a knob.

The vise used on this machine is of the quick-acting type and can be opened or closed through its full range of 24 inches in less than one second. The vise swivels up to 45 degrees and is substantially supported on an extension to the bed which is provided with a T-slot by which the outer end of the vise is guided. This T-slot also provides for clamping the vise rigidly in any required position. When the vise has been swiveled to the full angular adjustment of 45 degrees, work up to 15 inches can be handled. The lubricant for cooling the blade is contained in a tank located under the bed of the machine. In order to protect the teeth of the saw in cutting through thin flanges on structural steel, and also for adapting the machine for operation on the wide range of sizes which can be cut, the counterweight on the frame is made adjustable. For small work or while cutting through flanges on structural steel, the weight is moved back to its extreme position; but when the saw is working on large sections this weight is moved out to apply a pressure of 195 pounds on the cutting stroke. When the weight is moved back the saw frame is evenly balanced. The blades used may be from 12 to 32 inches in length and the stroke

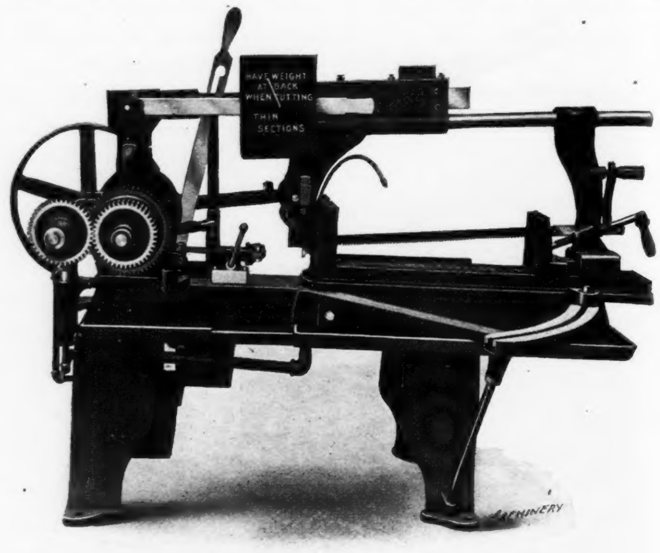
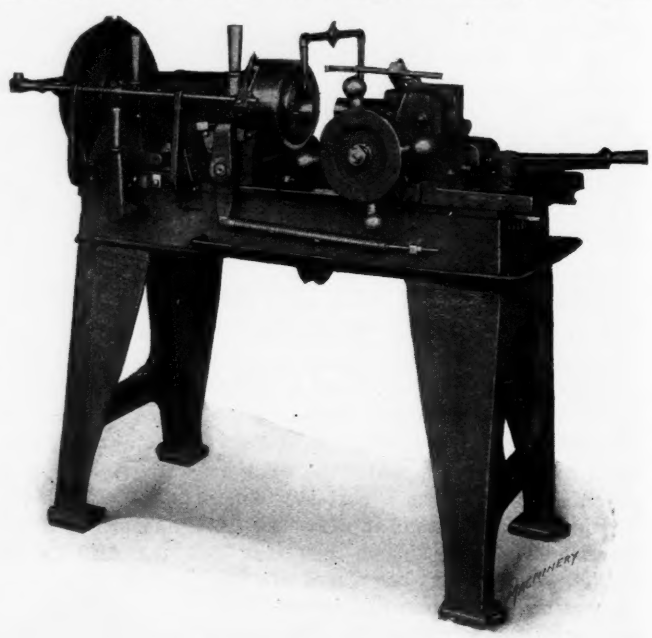


Fig. 2. Opposite Side of Machine showing Vise Support and Two-speed Drive

of the saw is 6 inches. The net weight of the machine is 900 pounds.

WILLIAMS PIPE THREADING MACHINE

The accompanying illustration shows a semi-automatic machine for cutting nipples, short lengths of pipe and bolts, which is a recent product of the Williams Tool Co., Erie, Pa. This machine is made in two sizes, one of which has a capacity for work ranging from ¼ to 1 inch in diameter and the other for work from 1 to 2 inches in diameter. The ma-



Williams Semi-automatic Pipe Threading Machine

chine is designed along lines which adapt it for a high rate of production. The pipe to be threaded is gripped in a sliding chuck, the jaws of which are operated by a screw and handwheel. The pipe is reamed while the thread is being cut and the dies open automatically.

LEES-BRADNER GEAR HOBBER

The Lees-Bradner Co., Cleveland, Ohio, has recently applied single pulley drive to its No. 5 gear generator in place of the cone pulley drive which was formerly used. The single pulley is situated below the shaft on which the cone was mounted. From this lower shaft gears transmit the power up to the original driving shaft. The gearing provides nine changes of speed for the cutter, with a range of from 44 to 147

revolutions per minute. The machine is double back geared with ratios of 3 1/3 to 1, and 10.8 to 1. The extreme ratio of 10.8 to 1 makes it possible to take advantage of the exceptionally rigid construction of the machine when operating on heavy work, while the ratio of 3 1/3 to 1 provides satisfactory results when using small hobs on light work.

The machine stops automatically when the work is finished, and the lever for starting is located at the front just to the left of the micrometer handwheel. This arrangement is the means of increasing the efficiency when the time required to

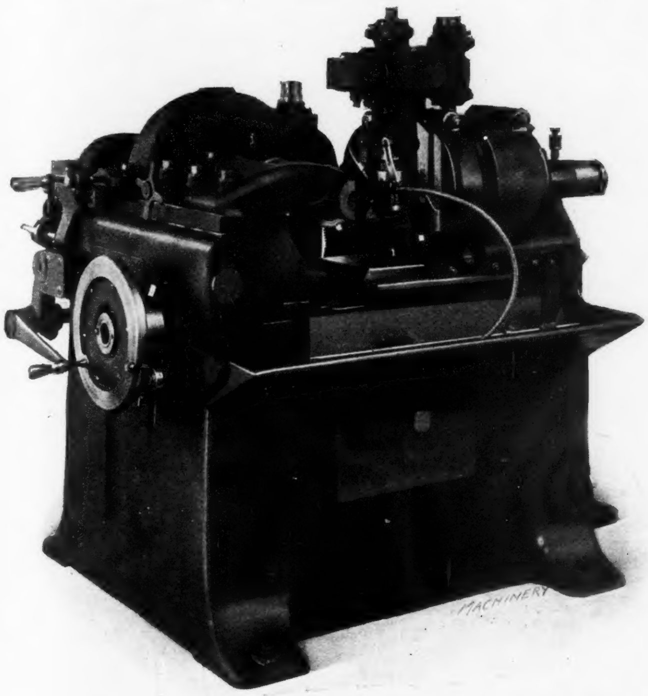


Fig. 1. Front View of Improved Lees-Bradner Gear Hobber

complete one set of blanks is not very long. With the present arrangement, the operator controls all of the movements from the front of the machine. The longitudinal feed of the work-slide is controlled by a hand lever which replaces the friction clutch formerly employed. A shield has been placed over the feed gearing and the shield may be readily swung back to cover the gears from the rotation shaft to the feed-screw, when used on the universal machine.

The new design makes the machine particularly well adapted for the application of individual electric motor drive. A constant-speed motor can be located at the rear of the machine either above or below the main driving pulley. The loose pulley is mounted on a roller bearing, with the

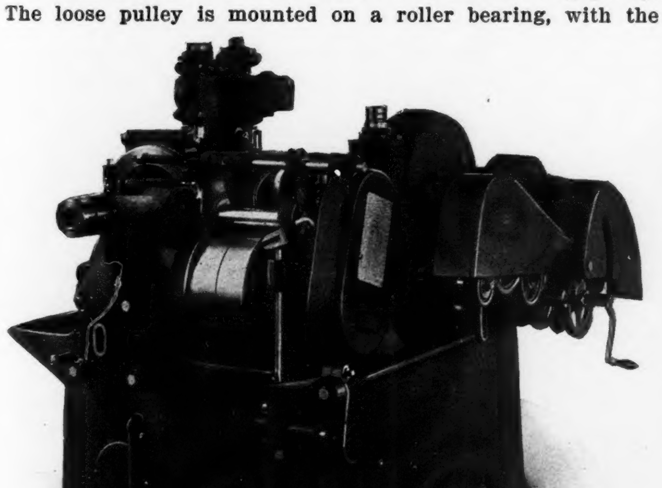
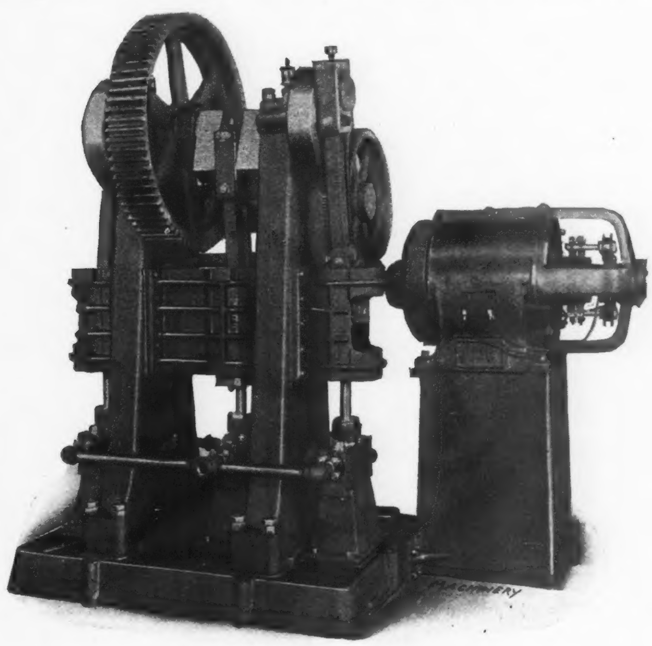


Fig. 2. Opposite Side of Machine showing Single Pulley Drive

rollers running on a hardened and ground bushing. In this way the trouble often experienced from loose pulleys wearing out their bearings and becoming noisy is done away with. This generator will cut spur gears, helical gears, worm-wheels and worms. The standard size in which the machine is built is for work up to 14 inches in diameter, but a special machine is also made which takes work up to 17½ inches in diameter. Worms 8 inches in diameter by 8 inches long and up to 1 inch pitch can be threaded on the universal machine.

HYDRAULIC TRIPLEX PUMPS

The accompanying illustration shows a vertical type of single acting triplex hydraulic pump which has recently been added to the line of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Pumps of this type are made in three series of sizes which are known as the Series J, Series JJ and Series JJJ. The Series J pumps have a stroke of 8 inches and are equipped with plungers ranging in size from ⅞ inch to 3¼ inches in diameter. The Series JJ pumps have a stroke of 12 inches and plungers ranging in size from 1 inch to 4½ inches in diameter. The Series JJJ pumps have a stroke of 12 inches and plungers ranging in size from 1¼ to



Hydraulic Style JJ Triplex Pump

5 inches in diameter. The pressure capacity is from 600 pounds to 16,000 pounds per square inch, depending upon the size of the piston. The pumps are either belt driven or equipped with individual electric motor drive. The J pumps require 25 horsepower to operate them; the JJ pumps require 50 horsepower, and the JJJ pumps, 100 horsepower. The effective speed of each of the three pistons is 33 1/3 feet per minute for the J pumps and 45 feet per minute for the JJ and JJJ pumps.

These pumps are fitted with screw glands working against followers when they are equipped for high-pressure work, or with stud glands when they are equipped with large pistons for low-pressure work. The pistons are packed with compression packing. Forged steel is used in the construction of the high-pressure pump cylinders and crankshafts. The cross-heads are guided and fitted with cast-iron adjusting shoes which are bored to provide a perfect guide. The connecting-rods are made of open-hearth cast steel and have bronze bearings with wedge and screw adjustments.

When these pumps are operated by belt, there is a single reduction of gears for the J pumps and double reduction for the JJ and JJJ pumps. The pulleys can be arranged to drive from either end. When motor drive is employed, there is a double reduction of gears for all sizes of pumps. The first reduction has a ratio of 5 to 1 and the second reduction depends upon the speed of the motor that is used. The height of the J pump is 5 feet 9 inches; of the JJ pump, 8 feet 1½ inch, and of the JJJ pump 8 feet 10 inches.

NEWMAN-COFFINGER DRILLING AND TAPPING MACHINE

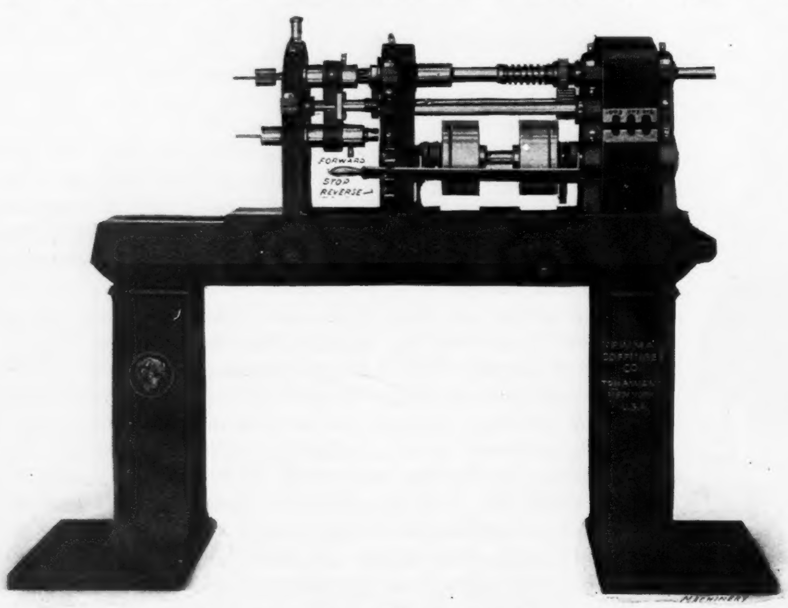
The combination drilling and tapping machine shown in the accompanying illustration is a recent product of the Newman-Coffinger Co., Tonawanda, N. Y. This machine is adapted for drilling, tapping, counterboring, hollow milling and similar operations. As two operations may be performed and the operator may be preparing another piece of work while the machine is so engaged, it will be evident that a high rate of production is attainable.

The method of operating the machine may be briefly described as follows: Assuming that one of the collets has been connected with the feed shaft, the operator shifts the drilling lever to the "forward" position. This connects the friction clutch with the forward driving pulley and starts the machine. The shaft upon which the driving pulleys and friction clutch are mounted transmits power to the spindle through a train of spur gears. Passing through the spindle there is a feed-shaft casing fastened to the spindle by a set-screw which slides in a groove to allow forward and reverse motion. The feed-shaft is fastened to the casing. This shaft is threaded at one end to provide for feeding the tool and there is a coupling at the other end which connects with the collets of the machine. The drilling and tapping spindles are bored No. 2 Morse taper.

The proper rate of feed is obtained by the train of gears previously referred to. The shaft upon which the clutch revolves has a driving gear keyed to it. This gear transmits power through an intermediate gear to the driven gear on the feed-shaft. The driven gear has a nut in it through which the threaded feed-shaft passes. When the hole has been drilled to the required depth the operator shifts the lever to the "reverse" position, which results in driving the machine in the opposite direction to back out the tool.

The turntable is actuated in the following manner: The feed-shaft passes through a neutral gear which becomes active when the direction of rotation of the machine is reversed. In this way the turntable is caused to revolve through one-half revolution, which is completed before the lever is shifted back to the forward position.

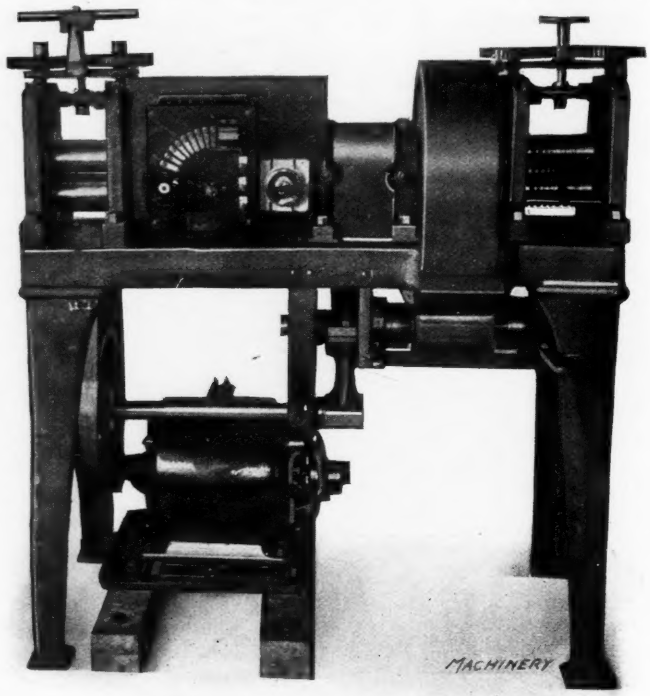
It will readily be seen that with the entire machine under instant control by means of a single lever, the operator would be idle during the time that the machine was working. To make use of this time, the turret tailstock is equipped with two work chucks. This makes it possible for the operator to be setting up a piece of work in one of the chucks while the machine is drilling and tapping another piece of work. When the drilling and tapping operation is completed, and while the machine is automatically reversing, the operator simply turns the turret around to bring the next piece into position to be machined. The machine can be built in various sizes and with either two or four collets. The work holding fixture is made to suit the requirements of the parts to be machined.



Newman-Coffinger Drilling and Tapping Machine

LEIMAN COMBINATION ROLLING MILLS

For use in rolling gold, silver, brass, copper and similar metals, Leiman Bros., 62 John St., New York City, have developed a combination rolling mill in which two sets of rolls are mounted in a single machine. The machine shown in the illustration is equipped with one set of rolls for flat work and one set for rolling wire, but machines may be equipped with two sets of rolls for flat work or two sets of wire rolls.



Leiman Combination Rolling Mill for producing Flat Work and Wire

Although these machines can be arranged for any form of drive, the most satisfactory method is that in which an individual motor is employed. Where this system is used the motor is mounted under the machine and provided with a rawhide pinion which meshes with the first spur gear. The power is transmitted to a second pair of spur gears and then through a pair of spiral gears to the driving shaft. The application of spiral gears in this machine is particularly important because the vibration would tend to take up the lost motion in spur gears and destroy the uniformity of the rotation of the rolls. This, in turn, would show itself on the work in the form of ripples. The frame and housings of the machine are of particularly rigid construction, reducing possibility of vibration to a minimum; and this precaution, in connection with the application of spiral gears, results in work of exceptionally good finish.

The ends of the driving shaft are squared and a sliding coupling fits over each of these squared ends of the shaft. These couplings are controlled by individual levers and may be slid over so that they connect with corresponding squared ends on the shafts which drive the rolls at either end of the machine. This arrangement makes it possible to operate both pairs of rolls at the same time, or to use either pair as required. The motor employed for driving the machine is of standard design and may be supplied in any desired voltage. For a machine equipped with one pair of flat rolls and one pair of rolls for rolling wire, the motor required to drive the machine should develop about 1½ horsepower.

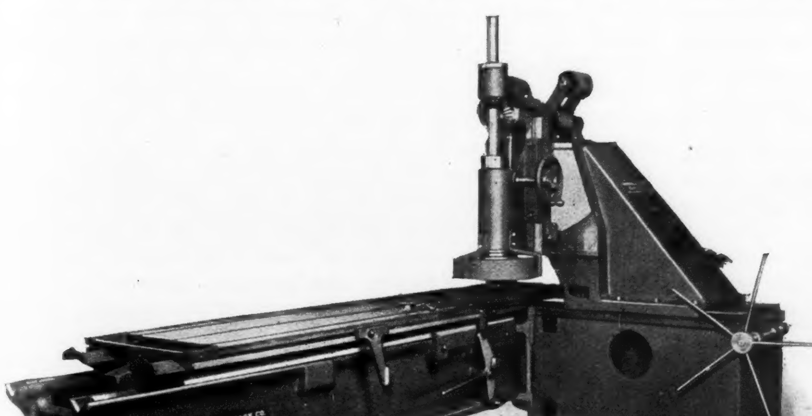
The rolls are made of a special steel which experience has shown to be suitable for this class of work, and the housings are equipped with bronze bushed bearings in which the rolls

run. A handwheel at the top of the housing at each end of the machine provides for adjusting the center distance between the rolls. The adjustment of either pair of rolls is secured by means of two screws which fit in tapped holes in the housings. When these screws are turned by means of the handwheel and gearing, yokes which fit over each end of the movable roll cause this roll to be raised or lowered as required. While both the flat rolls and wire rolls are provided with means of adjustment, it is not necessary to adjust the rolls used for producing wire. The spiral driving gear is located in the casing shown close to the wire rolls and the driving shaft which transmits power to the flat rolls is arranged with universal joints. The object of having the spiral gear close to the wire rolls is that the maximum adjustment for the flat rolls is made possible by this arrangement.

DETRICK & HARVEY GRINDING MACHINE

The grinding machine shown in the accompanying illustration is built by the Detrick & Harvey Machine Co., Baltimore, Md. This machine is particularly intended for edge grinding operations on safe and vault work but could be successfully employed in a variety of other lines. The table is 32 inches wide and gibbed down on one side to prevent it from tilting; the table speed is 24 feet per minute in both directions. The machine is belted to the countershaft and driven through a pair of bevel gears and a spiral worm engaging a rack on the under side of the table. The bed has two V-slides for the table, these slides being 21 inches between centers. It is planed on one side to provide a surface to which a sub-base is tongued and bolted. This sub-base is for the purpose of supporting the driving and belt shifting mechanisms.

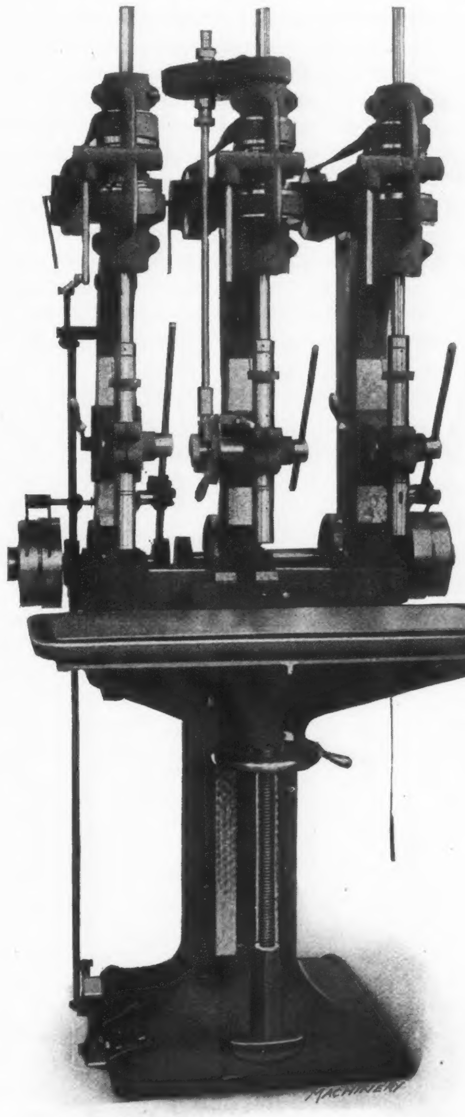
The spindle is 3½ inches in diameter and runs in a bronze bushed bearing, the bushing being tapered on the outside and provided with means of adjustment for wear. The spindle carries a grinding wheel 20 inches in diameter by 4 inches face width and runs at 600 revolutions per minute. Power is transmitted to the spindle through bronze and steel bevel gears, the power for driving the spindle being taken from the countershaft by an 8-inch belt. The spindle bearing has a vertical adjustment of 12 inches to provide for the proper alignment of the grinding wheel when the bearing is swiveled for angular grinding. This spindle bearing is clamped to a swiveling bracket which swings from a trunnion bearing through which the driving shaft revolves. A T-slotted plate is attached to the upright and the swiveling bracket is bolted to this plate. The upright is mounted on the top surface of the sub-base and can be adjusted either toward or away from the table. The adjustment is made by means of a handwheel and screw. The countershaft is of the hanger type and designed to run at 300 revolutions per minute when it is desired to operate the table at a speed of 24 feet per minute.



Detrick & Harvey Edge Grinding Machine for Safe and Vault Work

KERN BALL BEARING DRILL

The Kern Machine Tool Co., Hamilton, Ohio, is now building the three-spindle high-speed ball bearing drill press shown.



Kern High-speed Ball Bearing Drill Press

Several new ideas have been incorporated in the present machine. It will be noted that the left-hand head is equipped with a friction tapping attachment and that it may be operated by either a foot treadle or a hand lever. This arrangement enables the operator to use one hand to control the jig and the other hand to start and withdraw the tap. It will also be seen that the tapping column of the machine is provided with an independent backshaft which may be operated at 450 revolutions per minute. On the slow speed, this gives a tapping speed of about 300 revolutions per minute in addition to three higher speeds. At a tapping speed of 300 R. P. M. it has been found possible to tap cast-iron plates for ¼-inch gas pipe and produce a nice "full thread." The machine was also tested by tapping through a ¾-inch cast-iron plate with a ½-inch standard U. S. tap; and another test to which the machine was subjected consisted of tapping ½-inch flat steel bars with a ⅜-inch machine tap. Satisfactory results were obtained on all of these classes of work.

The middle spindle of the machine is provided with power feed. This feed mechanism is driven from the spindle by gearing which is fully enclosed, two changes of feed being provided—0.006 and 0.008 inch per revolution, respectively. The feed shaft comes down and is connected to the worm-wheel by hardened steel clutches; and a suitable trip lever is provided to either knock off automatically at any point to

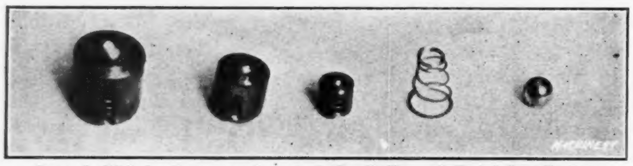
which the depth collar is set, or to be tripped by hand. In addition, the machine is provided with friction feed, the knurled nut at the left being used to engage or disengage the friction.

The right-hand head is equipped with the standard hand feed mechanism used by the Kern Machine Tool Co., which is too well known to require detailed description. As each of the drilling heads are individual units, more than one head can be equipped with power feed if so desired. Experience has shown that it is advisable to locate the tapping attachment at the outside of the machine on account of the necessity of reaching it with the foot treadle. With this combination of heads on a single machine, it is possible to drill several small holes by hand while the power feed is employed for drilling a deeper hole. Then if there is any tapping to be done, the tapping operations may be performed before the work is taken from the machine.

OSGOOD OIL-HOLE COVERS

The J. L. Osgood Co., 43 Pearl St., Buffalo, N. Y., is now making a line of oil-hole covers, which comprises seven different sizes ranging from 1/4 to 1/2 inch. Three of these sizes are shown in the accompanying illustration, together with one of the balls used to close the cover and the conical shaped spring which holds the ball in contact with the hole in the top of the shell.

A fairly good idea of these oil-hole covers will be obtained from the illustration. The cover consists of three parts—

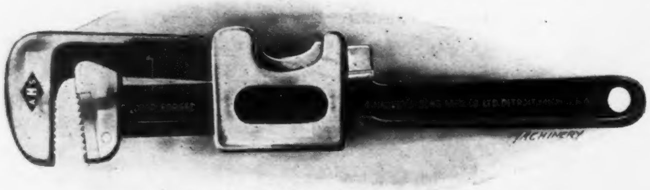


Osgood Oil-hole Covers and one of the Balls and Retaining Springs

the brass shell which fits into the oil-hole, the ball which closes the hole at the top of the shell, and a conical spring which retains the ball in position. The hole in the shell is machined to form a close fitting bearing for the ball, and in this way it is insured that the ball will always return to its proper position after having been pushed down by the nose of the oil-can. The brass shell is split at the bottom so that there is a certain amount of latitude to permit the shell to adapt itself to the size of the oil-hole. The bottom of the shell is spun over to retain the spring in place.

WRIGHT PIPE WRENCH

The A. Harvey's Sons Mfg. Co., Ltd., Detroit, Mich., is now making an adjustable pipe wrench which is illustrated herewith. The important feature of this tool is its simplicity, and the fact that it can be instantly adjusted for any size of pipe which comes within its range without requiring the use of both hands. This wrench consists of three essential parts, which are the rocking jaw, the yoke or frame and the handle bar on which the fixed jaw is formed. These parts pivot on each other instead of on a rivet and it is



Wright Pipe Wrench made by A. Harvey's Sons Mfg. Co.

claimed that this construction adds very materially to the strength and durability of the tool. If any one part of the wrench is held stationary, the other two parts pivot about it and this action has led to the use of the name "planetary wrench" as applied to this tool.

To operate the wrench, the man takes it in his hand and places his thumb on top of the back strap of the yoke. While pressing his thumb down on the back strap, he pushes the yoke forward or back to adjust the wrench to the required size. In setting for a given size the jaws are opened wider than the point at which they are required to be. The tip of the stationary jaw is then put against the pipe and the rocking jaw is pulled back against the pipe on the opposite side. The thumb pressure is then released and the wrench drops into the proper adjustment. It is used in the same way as any other pipe wrench. At present, the wrench is being made with a 9-inch handle and a pipe opening up to 1 inch; and with 14- and 18-inch handles, with a maximum pipe opening of 2 inches.

LANDAU MULTIPLE CHUCK DRILL

J. N. Landau, 101 W. 117th St., New York City, has recently brought out an automatic multiple chuck drill shown in the accompanying illustration. This little machine has a capacity for handling drills ranging in size from a No. 70 up to 1/4 inch in diameter, and reamers, counterbores, etc., of similar sizes. It will be seen from the illustration that there are five chucks in the turret. Tools required for performing successive operations on a piece of work are mounted in these chucks and can be rotated to bring them into the operating position. The multiple head of this machine may be attached to any drill press or the head may be set up in the tailstock of a lathe to serve as a turret attachment.

Five Spindle Landau Multiple Chuck Drill

The multiple head consists essentially of three parts—a stationary bonnet which is secured to the frame of the machine, a rotating turret in which are mounted any number of chucks up to ten, and the operating ring and handle which are used to rotate the turret. After any tool has finished its work the operator grasps the handle shown at the left-hand side of the head and pulls it around. The first movement of 15 degrees of the operating ring causes a cam to disengage the locking pin which holds the turret in any given position. As the ring continues to revolve, it pulls the turret around with it and the locking pin slips along until it registers with the next hole in the turret. The pin is pushed into this hole by a spring and locates the next spindle in the operating position. The operator then releases the handle, and the handle and ring are returned to the starting point by a spring.

Each of the spindles in the turret has a positive pin clutch at its upper end, and this clutch engages with a corresponding clutch member at the bottom of the machine spindle. The chuck in the operating position is the only one that rotates, so there is no waste of power in driving idle chucks. The arrangement of the drive will be evident from the illustration and the feed is obtained by the hand lever seen at the right-hand side of the machine. An eccentric adjustment is provided on the idler pulleys at the back of the machine so that the belt is lined up properly when changing from the fast to the slow speed or *vice versa*. This eccentric also provides a certain amount of adjustment for the belt tension. The mechanism is completely enclosed by the stationary bonnet and combines the features of strength and simplicity.

GARDNER NO. 1 DISK GRINDER

The Gardner Machine Co., Beloit, Wis., has recently added to its line of grinding and polishing machines the No. 1 disk grinder which is shown in the accompanying illustrations. Fig. 1 shows the floor type of machine which is equipped with disk wheels 12 inches in diameter, and with plain work tables. The spindle runs in ball bearings and is driven by a pulley 3 inches in diameter by 3 1/4 inches face width. The rocker shaft which supports the work tables is

1½ inch in diameter and 30 inches long. The floor space occupied by the machine is approximately 3 by 4 feet. The full equipment includes a countershaft, bench wheel-press, two extra disk wheels, an assortment of abrasive disks and the necessary glue and brushes for use in securing them to the wheels. The complete weight of the machine is 550 pounds.

Fig. 1. Floor Type of Gardner No. 1 Disk Grinder

Fig. 2 shows the same type of machine built for bench work. With the exception of the pedestal, this machine is of the same design as the floor type. The same equipment is furnished with both the floor and bench type ma-

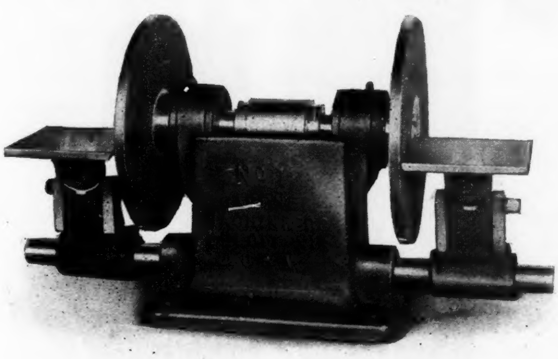


Fig. 2. Bench Type of Gardner No. 1 Disk Grinder

chines. These No. 1 disk grinders are built with ball bearings and are particularly adapted for use in tool-rooms, assembling departments, model works, garages and other places where small work is handled which is required to fit closely.

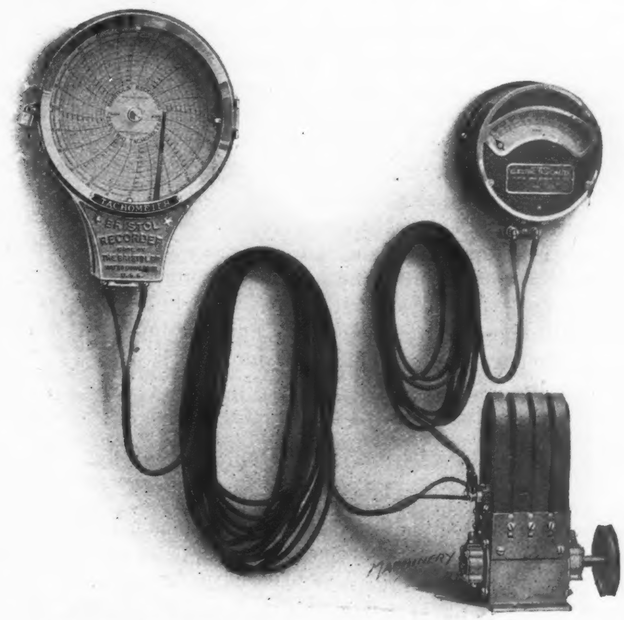
BRISTOL ELECTRIC TACHOMETER

The field of usefulness of recording tachometers covers the application of these instruments in connection with engines, machinery and shafting, where information is desired in regard to the speed of rotation. Some of the most important applications of instruments of this type are on engines, turbines, generators, blast furnace blowing engines, motors and pumps. As recording tachometers are usually required for continuous service under ordinary shop or mill conditions, they must be made especially durable.

The Bristol Co., Waterbury, Conn., has recently brought out an A. C. electric tachometer which has been particularly designed to adapt it for use in industrial plants. Two of the most important features of this tachometer which make it suitable for the rough usage which such instruments receive in industrial work are, first: the application of the induction magneto; and, second: the voltmeter movement. The application of the induction type of magneto eliminates the use of sliding contacts or brushes and the indicating and recording instruments are voltmeters.

The indicating instrument is equipped with a Weston jeweled pivot bearing voltmeter movement, and the recording instrument is equipped with an improved Bristol voltmeter movement which is so designed that ample power is provided for actuating the recording arm, even though the pen is in continuous contact with the chart. The movement is mounted on frictionless knife edge bearings and equipped with a new supporting device for the moving elements, which eliminates the effect of changes of temperature. This recorder can be furnished for use with 6, 8 or 12 inch charts.

The accompanying illustration shows a combination indicating and recording instrument. The indicating instrument is for the use of the operator and the recording instrument is set up in the office of the superintendent or foreman. Suitable lengths of leads can be furnished for locating either in-



Bristol A. C. Electric Recording and Indicating Tachometer

strument in any desired position. If so desired, connections can be furnished for more than two instruments. A simple form of this tachometer can also be furnished with either the indicating or the recording instrument as desired.

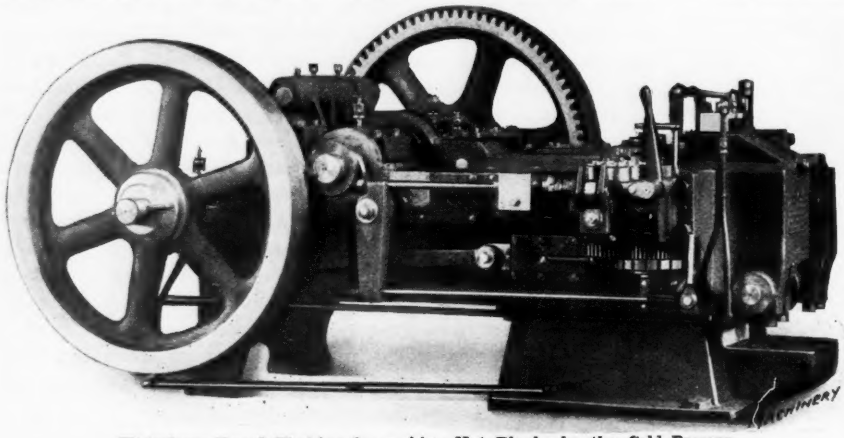
WATERBURY FARREL NUT MAKING MACHINE

To meet the demand for a large machine for use in the manufacture of nuts by the cold process, the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., is now building an automatic cold pressed nut machine which has a capacity for hexagon or square nut blanks ⅝ inch in size. The machine produces the blanks from bar stock and either hexagon or square blanks are finished complete, being chamfered and re-sheared and provided with a pierced hole ready for tapping, which is done on another machine.

In operating this cold pressed nut machine, one bar of stock follows immediately after another, with the result that it is unnecessary to stop the machine between bars and no short ends are wasted. In order to facilitate starting the stock into the ratchet driven feed rolls and between the straightening rolls, the latter are made with a quick adjustment for opening and closing them. In starting the stock it is necessary to have the end practically square before it enters the machine. This precaution guards against the possibility of breaking the punches. After the end of the

stock is between the open straightening rolls and gripped by the feed rolls, the straightening rolls are brought together by a lever. When the machine is working on bars of stock that are straight, the straightening rolls may be left open, as they are not required.

While the different operations performed in the machine are taking place, the tools are thoroughly flooded with lubricant which is pumped from the tank and delivered through a suitable system of piping and valves. The tank and pump constitute part of the regular equipment. As the lubricant flows away from the tools it is caught in a retainer and carried back to the tank. The scrap produced in making square nuts consists of the piercings and trimmings from the reshearing operation; and in making hexagonal nuts the scrap consists of the piercings, trimmings and the scalloping of the stock which is taken from the sides of the bars. The scrap is automatically separated from the finished blanks, the scrap falling into an iron pan and the blanks being delivered through a tube at the end of the machine. The machine illustrated in connection with this article is for making nuts ⅝ inch in size, but the Waterbury Farrel Foundry & Machine Co. also makes these machines for nuts ½, ⅜ and ¼ inch in size.



Waterbury Farrel Machine for making Nut Blanks by the Cold Process

NATCO NO. 26 MULTIPLE SPINDLE DRILL

The National Automatic Tool Co., Richmond, Ind., has just added to its line of multiple spindle drills the No. 26 machine illustrated herewith. This is a much larger and heavier machine than the other sizes built by this company and was designed to meet the demand for a multiple spindle drill having a capacity up to 1 inch. It is built along simple and sturdy lines and ample power is provided to drive high-speed drills at their maximum efficiency, regardless of the speed.

It will be seen that single pulley drive is employed so that the machine may be belted direct to the line-shaft if so desired. However, it is a very simple matter to apply individual motor drive. The driving pulleys are of large diameter and wide face and are mounted on Hyatt roller bearings. The speed box is located at the top of the column of the machine and three changes of speed are provided by the sliding gear transmission. The gears, which are of coarse pitch and wide face, are hardened. Any one of the three available speeds is obtained by shifting the hand lever to one of the positions marked *A*, *B* and *C*. For each speed obtained from the speed box, two changes of speed may be made by means of gearing in the head. These changes are made while the machine is running.

The bearings in the speed box are also provided with high-duty Hyatt roller bearings which insure a high transmission efficiency. The speed box and feed box gears are provided with the cascade system of lubrication and a sight-feed oil glass shows the operator at a glance whether the pump is working properly. There are three independent drill feeds which permit the use of any feed with either of the three double drill speeds that are available in the head. All of the feed changes can be made while the machine is running. The feed box is located at the base of the column of the machine and the feed gears are of hardened steel. They are of large diameter and run at moderate speeds. It will be noticed that the cover of the feed box is provided with a small tray that is particularly convenient for holding tools.

The machine is mounted on a heavy base which is provided with an oil channel for catching the overflow. This channel has a screened pocket through which the cutting lubricant must flow to enter the tank from which it is pumped back to the tools. The pumps employed for oiling the machine and delivering cutting lubricant to the drills are independent of each other. When so desired, the base of the machine may be provided with T-slots.

Several sizes of heads can be used on this machine and these heads may be equipped with various combinations of adjustable spindles and cluster boxes for carrying drills ranging from ⅛ to 1 inch in diameter. The head used on the machine is provided with power feed and a pilot wheel to facilitate advancing or returning it easily and rapidly. The power feed may be tripped either automatically or by hand. Referring to Fig. 1, it will be seen that the head is counterbalanced by two chains that support a counterweight contained in the column of the machine, which is of box section. The spindles are made of special steel, hardened and ground and provided with ball thrust bearings at the lower end, and lock-nuts at the upper end to take up any end wear that may develop. The spindles are made to carry either straight shank or Morse taper shank drills, as required. Individual flexible oil tubes deliver the cutting lubri-

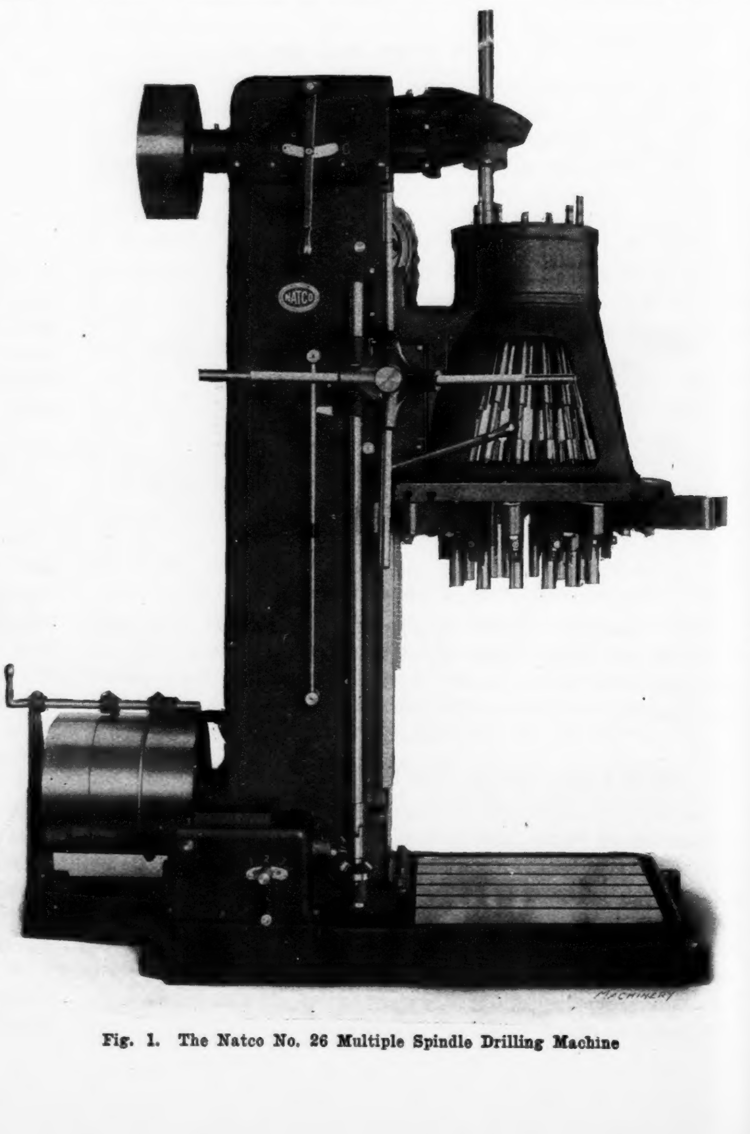


Fig. 1. The Natco No. 26 Multiple Spindle Drilling Machine

cant to each drill when the machine is working on steel or aluminum.

The bronze bearings which carry the drill spindles are provided with vertical adjustment to compensate for variation in the drill lengths. This adjustment is quickly and easily secured by simply loosening one nut which is always accessible, regardless of how close the spindles may be clustered together. This spindle adjustment—which is a patented construction—holds the bearing rigidly to the end of the arm, and the arm may be moved to cover any layout within the range of the head. The construction is illustrated in Fig. 2. In making the adjustment, it is only necessary to loosen the nut *A* as mentioned. This allows the steel beam *B* to rock on its fulcrum and loosen the bearing to provide for making the adjustment. The ball thrust bearing on this spindle is shown at *C* and the lock-nuts and washer for taking up end wear are illustrated at *D*. It will be seen that an oil chamber is provided in the bronze bearings in order to insure adequate lubrication of the spindles. The universal joints used on the Natco multiple spindle drills are milled from the solid and carefully hardened. One of these joints is shown at *E* in Fig. 2. This is composed of only five pieces and does not depend upon a cross-pin that may be broken, or upon screws that may work loose. These universal joints are guaranteed to stand up for two years.

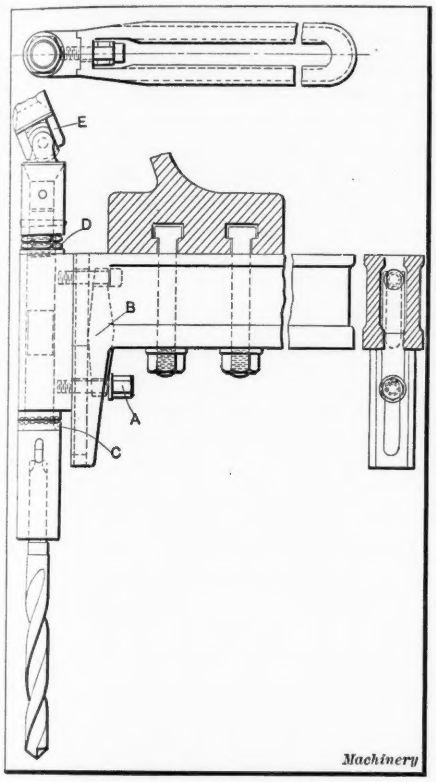


Fig. 2. Quick-acting Device for making Vertical Adjustment of Spindle Bearings

One of the most important features of this machine is the independent drill speeds in the head, which give two independent changes of speed to each spindle for each of the three changes of speed obtained in the gear box. It is well known that it is impractical to drive drills of different sizes at the same speed and feed per revolution, and the Natco independent drill speed feature gives approximately the correct speed and feed for each size of drill that comes within the range of the machine. For example, using ½-inch and 1-inch drills in cast iron, it is possible to secure a feed of 4.72 inches per minute. For this purpose the speed box lever is shifted to station *B* which gives 547 revolutions per minute or 71.5 feet per minute as the peripheral speed of the ½-inch drills which are fed at 0.0086 inch per revolution. By shifting the driving pinion in the head which drives the 1-inch drills these drills can be driven at 271 R. P. M. or 71 feet per minute, with a feed per revolution of 0.0174 inch per revolution. It will be noted from the preceding that the peripheral velocity of the drills in feet per minute is practically the same, while the feed of the ½-inch drills is only one-half as great as that of the 1-inch drill. Experience has led the National Automatic Tool Co. to believe that cone pulleys for driving and feeding machines of this type are unsatisfactory, while very gratifying results have been obtained with the powerful single pulley drive with geared feeds now employed.

* * *

More than 32,000 tons of aluminum was consumed in the various industries in the United States during 1913.

NEW MACHINERY AND TOOLS NOTES

Pinion Rod: Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J. The pinion rod recently placed upon the market by this company is made in any length and with the teeth either straight or helical, and of either regular or odd shape.

Baling Machine: Famous Mfg. Co., East Chicago, Ind. A machine for baling sheet metal scrap which is arranged for either belt or motor drive. The sides and ends of the box in which the material is pressed are built of rolled steel sections bolted together.

Sensitive Drilling Machine: Berghauser Machine Co., Cincinnati, Ohio. A sensitive single-spindle drilling machine equipped with a feed box which has a series of steel sliding gears running in oil. Nine changes of speed are provided, ranging from 225 to 1850 R. P. M.

Link Grinder: Newton Machine Tool Works, Inc., Philadelphia, Pa. A radius link grinder for finishing the slots in hardened locomotive links. For narrow slots and those with little end clearance, small wheels are used, while on larger sized links the entire face is ground at one time.

Milling Attachment: Cincinnati Pulley Machinery Co., Cincinnati, Ohio. A milling attachment for use on the lathe which is particularly adapted for the use of jobbing and repair shops. It will do various classes of work which are ordinarily handled on standard milling machines.

Drilling and Tapping Chuck: Victor Tool Co., Waynesboro, Pa. The collets of this chuck are driven by a key which is released when the sleeve of the chuck is raised. The tapping chuck is provided with an adjustable friction which may be set to the desired tension so that the drive will be released before the tap can be broken.

Baling Press: Logemann Bros. Co., Milwaukee, Wis. A hydraulic press for baling scrap brass, copper, aluminum, sheet steels, etc., into compact bundles ready to be remelted. These machines are built in three sizes. The pressure is obtained from a double system of hydraulic rams which compress the scrap in a covered box.

Radial Drill: Cincinnati Bickford Tool Co., Cincinnati, Ohio. A radial drill which is driven by a Westinghouse adjustable speed motor with the controller mounted on the head of the drill. Compressed air is used to bind the column and lock the arm in position, the air control lever being conveniently located for the operator.

Tapping Attachment: Hoefer Mfg. Co., Freeport, Ill. The reverse motion of this tapping attachment is either controlled by the hand lever or by an automatic trip secured to the front of the machine. The automatic trip is operated by the collar on the quill, which is set to reverse the tap when it has reached a predetermined depth.

Drill Chuck: Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y. In the October, 1912, number of MACHINERY the automatic Wahlstrom drill chuck for straight shank drills was illustrated and described. The company has now brought out a similar chuck, the design of which has been modified to adapt it for handling taper shank drills.

Sand-blasting Outfit: Carter Metals Cleaning Co., Philadelphia, Pa. A sand-blasting outfit which uses air at a pressure of from 80 to 100 pounds per square inch. The compressed air passes through the upper hose connection of the nozzle and the sand from the lower hose meets the air inside the head and is projected from a ¼ inch orifice in the nozzle.

Automatic Drilling Machine: Standard Mfg. Co., Bridgeport, Conn. This machine is equipped with automatic cam feed so that the operator has to simply load and unload the jigs. The cams are so timed that the drilling operations performed by the four spindles proceed progressively. Adjustment is provided for the depth of hole and the range of drilling.

Drilling Machine: Taylor & Fenn Co., Hartford, Conn. The important feature of this machine is the provision of safeguards which protect every part of the mechanism. The only possible way in which the operator could be injured is by putting his hand under the drill. This machine is known as the type C. Each spindle has independent automatic feed and quick return.

Combination Shear and Punch: Schatz Mfg. Co., Poughkeepsie, N. Y. A combination shear and punch which combines three separate units. The first of these is a plate shear for cutting plates of any desired length or width. The second unit is a punch for punching sheets, plates and structural shapes and the third unit is a shear for cutting structural material at right angles or on a miter.

Power Press: Max Ams Machine Co., Mount Vernon, N. Y. A line of double crank cutting and stamping presses which are adapted for handling a great variety of work for which machines of this type are used. The machines are made in four sizes with capacities of 15, 25, 50 and 100 tons, re-

spectively. Each size is made in a number of different widths between the housings, ranging from 24 to 120 inches.

Multiple Spindle Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A high-speed multiple spindle drilling machine in which each spindle has independent vertical adjustment controlled by an outside clamping screw. The drive is through helical gears which are enclosed in a case and immersed in oil. The main driving shaft slides up through the yoke or down through the head, thus economizing in overhead space.

Abrasive Wheel Cutting-off Machine: Nutter & Barnes Co., Hinsdale, N. H. In the December, 1910, number of MACHINERY, the abrasive wheel cutting-off machine of this company's manufacture was illustrated and described. This machine was equipped with a handwheel and screw for clamping the work in a V-block. This was a slow method and has recently been improved by the substitution of a lever-operated device which can be manipulated much more quickly.

Tapping Chuck: Cincinnati Bickford Tool Co., Cincinnati, Ohio. A tapping chuck designed for use in upright, horizontal or radial drilling machines, which are not provided with a tap leading mechanism. With this device, the danger of stripping the threads or reaming out the hole while drawing to start the tap is eliminated. The chuck consists of a driving spindle and a floating outer sleeve which have two rectangular ball bearings in place between them that drive the outer sleeve. The tap holder and tap are attached to this sleeve.

Screw Plates: Russell Mfg. Co., Greenfield, Mass. Two screw plates known as styles A and B, respectively. Style A plate is very simple to adjust, adjustment being accomplished by a single screw, while the die is in the stock ready for use. In the style B plate, the screw guide forces the beveled edges of the die against the beveled surfaces of the collet. As these beveled surfaces are identical in form, a combined screw and taper fit is effected which compensates for wear. The adjustment of the cutting size is accomplished by turning screws located back of the die.

Drilling Machine: Kern Machine Tool Co., Hamilton, Ohio. Two types of drilling machines. One of these is a tilting table machine on which the table may be swung to any angle. The table is rigidly held on the saddle by four bolts. The second machine is a heavy-duty drilling machine, the design of which combines a number of interesting features. There are nine changes of speed and eight changes of feed. Double back gearing is provided through gears which may be slid into engagement without stopping the machine. A feature of the machine is a ball thrust bearing under the bevel gear which is used to elevate the table arm.

Double Seaming Machine: Charles Leffler & Co., Brooklyn, N. Y. An automatic square double seaming machine primarily adapted for use in the manufacture of double seamed tin cans of the kind used in packing tobacco, talcum powder, etc. The machine is driven by a two-step cone pulley and friction clutch. The operator is merely required to place the can on the chuck and depress the treadle which causes the lower spindle to rise and engages the clutch, thus starting the driving shaft and the chuck spindle. The double seaming rolls are brought into action automatically while the can is making the required number of revolutions. The clutch is then disengaged automatically and the work is released.

* * *

OCCUPATIONS OF ENGINEERING GRADUATES

The College of Engineering of the University of Illinois has collected data relating to 2165 graduates in order to ascertain the branches of work in which they are engaged. It is of interest to note that 89 per cent are engaged in one way or another in engineering work, while 8 per cent have gone into other fields, the remaining 3 per cent having passed away. Out of every 100 engineering graduates of the University of Illinois, we thus find that 63 per cent are employed by corporations engaged in one way or another in engineering work; nearly 15 per cent have become architects; 6 per cent hold executive positions with engineering companies; 4.5 per cent are teachers in engineering colleges and nearly 1 per cent are consulting engineers. Of those engaged in non-engineering occupations, 2.4 per cent have turned to farming; 1.4 per cent are merchants; 0.9 per cent hold executive positions with mercantile companies; and a comparatively small number are lawyers, physicians, bankers, army officers, salesmen, real estate and insurance brokers and editors of non-technical journals. The percentages represented by these various occupations vary from 0.24 to 0.9 per cent.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The twelfth semi-annual convention of the National Machine Tool Builders' Association was held at the Hotel Bancroft, Worcester, Mass., April 23-24. The place of meeting was first fixed in New York City, but the fact that the convention of the National Metal Trades Association, whose membership includes some of the machine tool builders, was to be held in Worcester the same week, caused the management to make the change of place shortly before the meeting. That Worcester did herself proud in providing entertainment and accommodations was heartily conceded by all.

The meeting was called to order by President W. A. Viall of the Brown & Sharpe Mfg. Co., whose address of welcome sounded an optimistic note. He was confident that normal conditions of prosperity in the machine tool trade would be soon restored and counseled the members to plan for the future and take steps to improve manufacturing and selling facilities.

Charles E. Hildreth, the manager of the association, begged the members to respond to letters of inquiry and promised to see personally all of them in their places of business. He pleaded for more personal acquaintanceship and cordiality.

J. H. Drury, of the Union Twist Drill Co., reported the name of one new member, Williams White & Co., Moline, Ill. The committee report on standardizing grades of grinding wheels was a resumé of the factors to be considered and was decidedly discouraging as to the feasibility of establishing a uniform grading system. The number of abrasives, the sizes of grain, the varieties of bond and other factors to be considered make a vast number of possible combinations. That it will be possible to establish a system of grades which will be uniform for all makes of wheels seems doubtful.

Charles Fair, of the General Electric Co., presented an analysis of the conditions that must be met in standardizing electric motors for machine tools. This problem, too, seems difficult of solution, but something may be accomplished in establishing a near standard from which many differentiations of equipment must necessarily be expected.

The paper by J. C. Spence, superintendent of the Norton Grinding Co., "How Can We Induce Ourselves and Our Men to Earn More Money," was enthusiastically received and discussed. Mr. Spence got down to the fundamentals of personal relationship between employers and employes and pointed out how necessary it was to engender confidence of the men in the management to obtain the highest production. This paper will appear in a later number.

The afternoon of the first day was given over to committee meetings. In the evening a "Good Fellowship" dinner was given in the Hotel Bancroft which was attended by about 280. It was marked by no toasts or speeches, but a unique and most enjoyable entertainment was provided by talent of the Norton Grinding Co. The farce and minstrel show called "High Speed Steals," which concluded the evening, was received with uproarious applause.

Friday forenoon was given to committee meetings and the fourth session in the afternoon was occupied principally by an illustrated paper, "Safety as Applied to Grinding Wheels," by R. G. Williams, safety engineer of the Norton Co., and committee report on safeguarding grinding wheels.

The number registered in attendance to the convention was 169, which is more than was ever before registered at a semi-annual meeting.

* * *

The rack-and-pinion-type locomotives that haul cars to the top of Mount Washington, N. H., take water from a pipe along the track instead of carrying it in a tender. The water is pumped to the top of the mountain by duplex pumps near the base, which pump against a pressure of 2250 pounds per square inch. The pumps are located at 2540 feet above sea level and pump water to the summit at an elevation of 6280 feet. The pipe line to the summit is two inches in diameter and one-half inch thick for half its length and three-eighths inch for the remainder of the distance.

MAKING THE OSGOOD OIL-HOLE COVERS

The operations involved in making the Osgood oil-hole covers are interesting for two reasons: First, because the operations of turning and cross-slotting the brass shells, assembling the ball and retaining spring in place, spinning over the edge of the shell and cutting it off. are all performed in the turret lathe, without requiring the spindle to be stopped. Second, in developing this sequence of operations, a special cross-sawing attachment was designed for cutting the slot in the bottom of the brass shells.

The first operation consists of feeding the stock up to a stop, and the second and third operations are those of spotting, drilling and forming the seat for the ball. After the work has progressed to this point it must be slotted, and the cross-sawing attachment illustrated in Fig. 1 is used for this purpose. Referring to this illustration the barrel *A*, of which the flange *B* is an integral part, is screwed onto the nose of the turret lathe spindle. The four pins *C* which guide the plate *D* are secured in the flange *B*. The plate *D* is normally held in its outermost position by spiral springs *E*.

The tool *F* is clamped to the turret, the working parts of the tool being free to turn on the shank. The friction wheels *G* and *H* are carried by bearings at right angles to the turret-

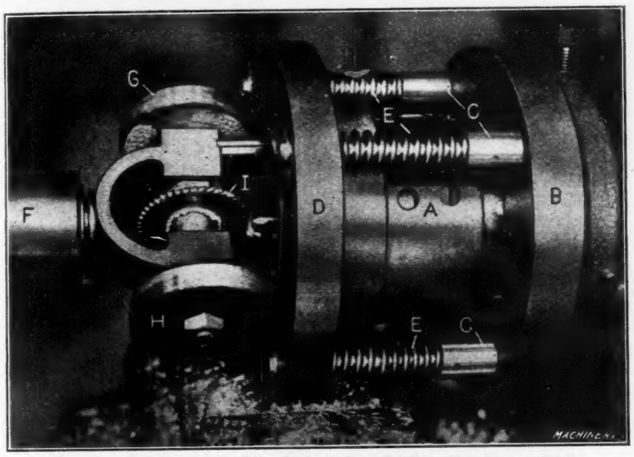


Fig. 1. Cross-sawing Attachment for slotting the Brass Shells

tool shank. These wheels are made to revolve through their contact with the plate *D*, which is revolved on the end of the lathe spindle. The friction wheel *G* simply acts as a balancing idler for the other wheel *H*. When the turret tool is brought up to the work, a lock on the turret tool engages a lock finger on the spindle nose attachment and causes the tool *F* to rotate in unison with the spindle. Pressure of the turret tool against the plate *D* causes this plate to move back

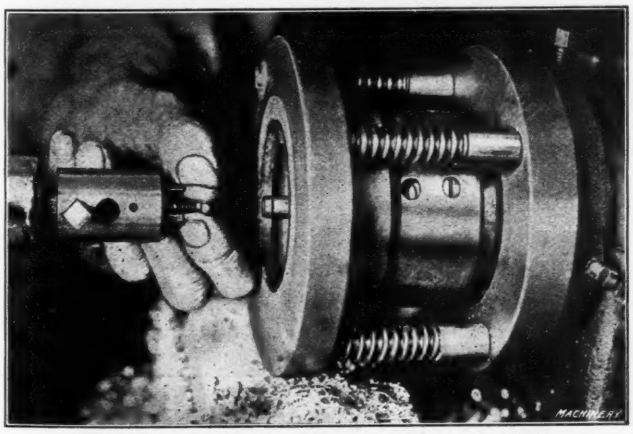


Fig. 2. Assembling the Ball and Spring in the Shell

against the tension of the springs *E*. At the same time the wheel *H* drives the saw *I* which cuts the slot in the brass shell.

After completing the slotting operation, the ball and spring are assembled, as shown in Fig. 2, and the edge of the shell is spun down to retain the spring in the shell. While this spinning operation is being performed, the slots in the shell are closed so that the work is not distorted. The cutting-off operation illustrated in Fig. 3 is next performed by operating the cam lever. This causes the cutting-off tools to move in and sever the completed oil-hole cover from the bar. As cut from the bar, the cover is ready for use and the time required to make a complete cover is about fifteen seconds. From this it will be readily seen that the operation of the slotting tool is quite rapid. The J. L. Osgood Co., 43 Pearl St.,

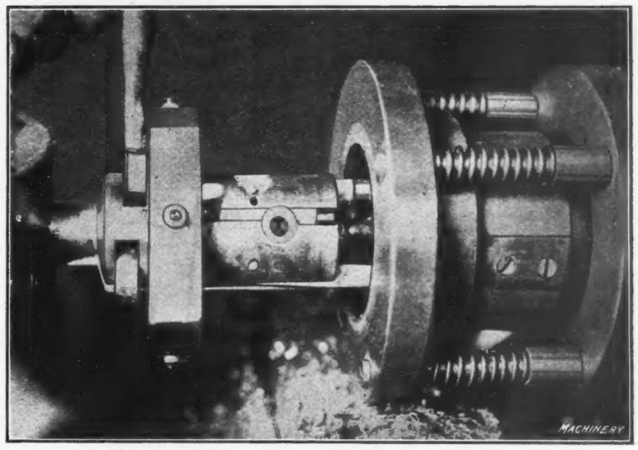


Fig. 3. Cutting off the Completed Oil-hole Cover

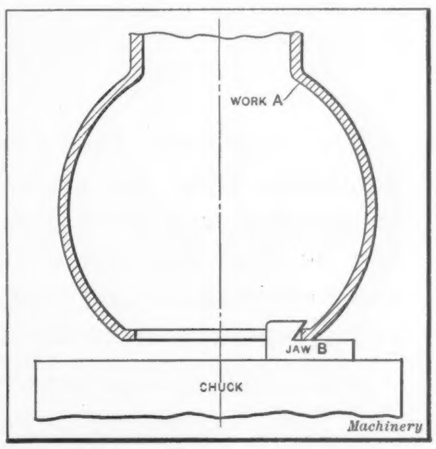
Buffalo, N. Y.. is prepared to furnish the cross-sawing attachment described in this article to manufacturers who have turret lathe work for which it is adapted. The Osgood oil-hole cover is described in the New Machinery and Tools section of this number of MACHINERY.

* * *

HOLDING DEVICES FOR FIRST-OPERATION WORK

BY ALBERT A. DOWD*

Answering the criticism by F. H. Bullard in the February number of MACHINERY, regarding my article on "Holding Devices for First-operation Work" which appeared in MACHINERY for November, 1913, I wish to say that he is correct in regard to the expense of some of the fixtures shown. The first cost of a fixture is a minor item, however, in comparison to convenience and rapidity of operation when a large number of pieces are to be machined. Referring to the fixtures described in the article mentioned, it will be noted that Figs. 1, 2, 4, 5, 6, 7, and 10 are either component parts of an automobile or they are portions of accessories used in automobile construction. The smallest number of pieces in this group is 5000 and the largest 100,000 for a year's production. It must therefore be admitted that the first cost of the fixtures shown is a negligible item, when compared to the saving in time effected by their use. The manufacturer of today is looking for production first, last, and all the time, and he would not for a moment consider the use of a fixture which would involve any great amount of labor in setting the work in position, no matter how cheaply the fixture might be made.



Special Form of Jaw for Holding Ball Joint

Regarding Fig. 3, the fixture for which is rather harshly criticised by Mr. Bullard, the writer stated in the last paragraph describing this fixture that "a method of holding this work by the interior undoubtedly would have been more satisfactory," meaning some device similar to that shown in Fig. 6. Perhaps a slight explanation will make this matter somewhat clearer and will show why the device illustrated was used in this particular instance. A number of castings were sent by a foreign government, as sample castings for which

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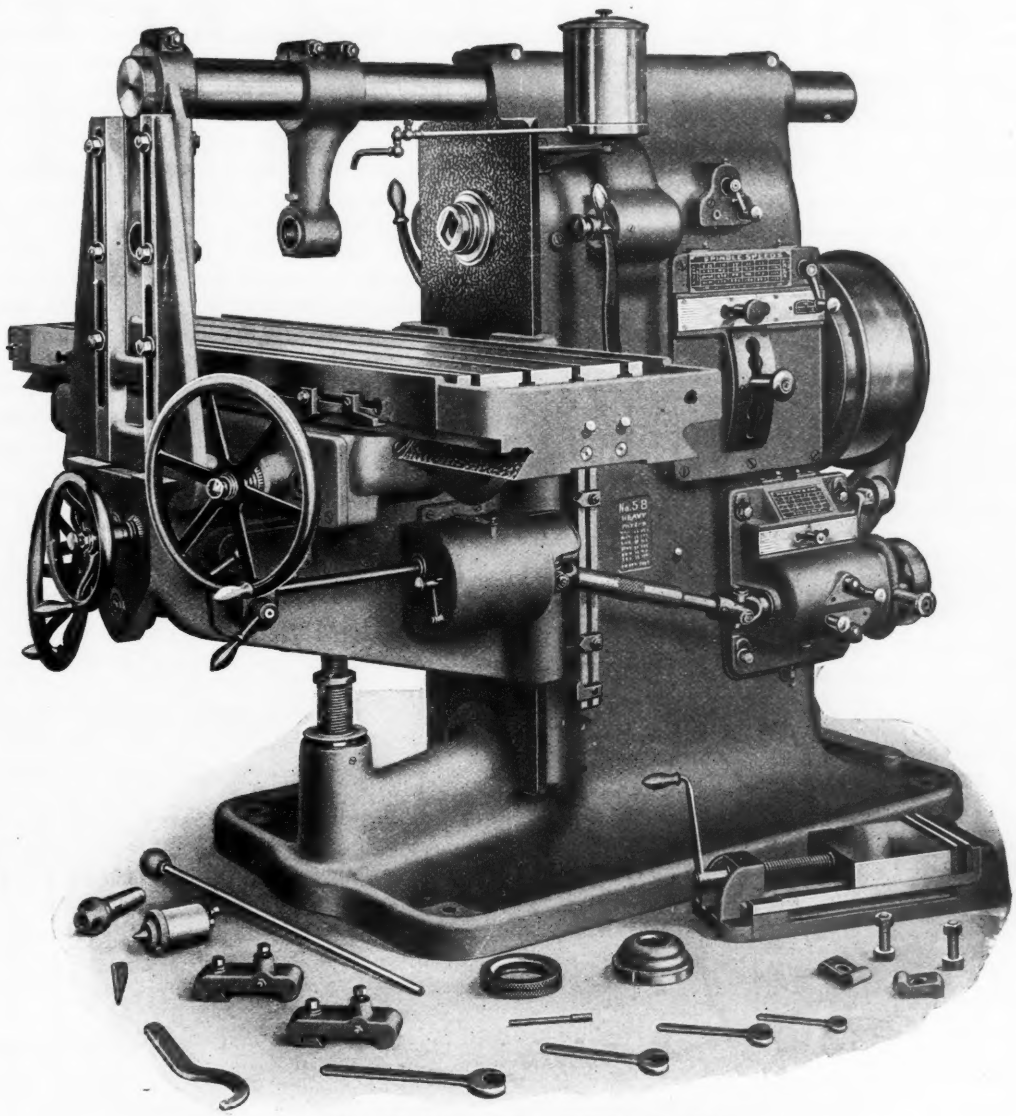

No. 5B Heavy Plain Milling Machine

Heavy Service Milling Machines Designed for Easy Operation

In addition to the Automatic Fast Feed, our Heavy Service Plain Milling Machines are provided with many other features making them easy to operate.

The knee is efficiently clamped to the column from a single point at the front, saving time on shifting from roughing to finishing cuts.

All hand wheels and levers for controlling movements of the table are grouped at the front.

All feeds are started, stopped or reversed by a single lever on the side of the knee.

Gears which are often thrown into engagement have special pointed teeth so they always slip easily into mesh without bruising.

We should be glad to advise methods of handling your work.

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Ottawa, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a/M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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fixtures and tools were to be designed; and in view of the fact that the location of the plant to which machines and tools were to be sent was nearly half way around the globe, it is evident that it would have been out of the question to suggest changes in the pattern, as this would have necessitated a delay of two months at the very least. It will, therefore, be readily apparent that it was essential to handle the castings *just as they were*, without taking liberties with the design. The method suggested by Mr. Bullard of holding by the inside of a flange in a three-jawed chuck would hardly be practical on account of the narrow gripping surface provided for the jaws, unless these were of special design as shown at *B* in the accompanying illustration. This design would then have a tendency to crowd the work back against the face of the jaw so that it would be securely held. Even under these conditions, it is highly probable that there would be more or less "chatter," for with the method described in the original article there was a slight tendency to "chatter," although the manner of gripping was such as to prevent this to a great extent on account of the metal-to-metal holding method, which killed vibration of the casting to a considerable extent.

Regarding the use of the "bull center" as a support; this is obviously out of the question, as the casting is in the rough at the end where the center is used. This is used merely to approximate the cored center of the work while the hook-bolts are being tightened. Regarding the use of clamps for holding on internal lugs, as mentioned by Mr. Bullard, it would give the writer great pleasure to have the method fully described, showing how the clamps would be operated and set up firmly on the internal flange. This would be possible on a special fixture or by the use of a socket wrench for tightening, but I fail to see how the work could be centered by the plug at the same time. It would also be a difficult matter for the operator to see what he was doing, even if the work were set up on blocks to let in the light at the ball end of the work.

In connection with suggestions regarding desirable pattern changes, this matter can be very easily arranged when the factory designs the work for which it also makes the tools, but when an outside customer's castings are involved it is sometimes inadvisable to suggest changes, as a number of castings may be already on hand. The writer will not soon forget a pattern change which seemed desirable for chucking purposes, the work in question being a pot casting for a large automobile factory in the middle west. The suggestion was made and the answer came back: "10,000 castings on hand. Cannot change pattern." There was also an intimation that if we could not design a fixture to hold the work as it was, some other firm might be able to do so. Needless to say, the fixture was designed for the sample casting sent us, and nothing more was said about changing the pattern. It may be seen from this that it is not always wise to suggest changes, as some manufacturers do not take kindly to it. A knowledge of the number of castings on hand is valuable when changes are to be proposed and this information is not always available.

I fully agree with Mr. Bullard's statement that the "designer of any piece of machinery should not only be capable of designing mechanism that will perform the functions desired, but should so shape the various parts that they may be readily machined in ordinary machine tools with the least possible outlay for special equipment." I think, however, that he has not considered the matter from the point of view of the machine tool builder who is called upon to furnish machines and equipment for a great variety of work in which changes in patterns would not be permitted on account of the number of castings which might already be on hand. For this reason the writer does not quite see how he "has failed in just this respect," especially as the customers who received and used the devices illustrated were perfectly satisfied with them, and in several instances duplicated their orders within a short time after their receipt and trial. If this is a sign of failure, most of us would be glad to fail continually.

In regard to handling the larger ball joint shown, by either of the methods suggested by Mr. Bullard, I will say that as the weight of a single one of these castings would approximate 2300 pounds or something over a ton, it would be an expensive proposition to "scrap" one of them. Suppose there are two or three on hand which must be either machined in some way or "scrapped." It would undoubtedly be a difficult matter to hold the work with the flange side up, in any sort of standard equipment with which the writer is familiar. Neither a three- or a four-jaw chuck would have sufficient gripping surface to hold the piece securely unless very light cuts were taken. If, on the other hand, the work was held with the ball end up by means of clamps and dogs, then the second setting would present some serious difficulties in the matter of holding and driving. Again, supposing that it was permissible to change the pattern, as suggested, before any castings had been made, the jaws could then be brought up on the inside and additional screw dogs used to assist in driving. How could the screw dogs be tightened unless a special wrench were provided? And even then it is doubtful whether the work could be held securely. The fact of the matter is that so little frictional surface can be obtained on the ball end (due to its shape) that some sort of a seat which will conform to the shape of the casting is needed in order to provide the necessary surface. The use of ordinary clamps would be difficult and would be open to the same objections as those already mentioned. A set of cast-iron blocks could be bored out in position on the table of the machine and clamps used to draw the casting down upon them, thus providing frictional surface enough to hold the work, but even if this were done the clamping would be attended with some of the difficulties previously referred to.

In conclusion I will say that I believe the method shown in Fig. 12 is thoroughly practical and not excessively expensive in spite of the adverse criticism regarding it. Sketches illustrating the exact method proposed by Mr. Bullard would be greatly appreciated and would perhaps make clear some of the points which at present do not seem entirely logical or practical.

* * *

NOMENCLATURE OF ALLOYS

A committee of the Institute of Metals which was appointed in 1912 to report upon the question of the nomenclature of alloys has presented a report embodying its first series of recommendations. The work has been approached in a practical manner and the demands of industry and commerce have been borne in mind. It has been attempted to adhere, as far as possible, to existing names sanctioned by long usage, to avoid coining new names or adopting recently coined names, and to employ simple English names throughout. The committee has, in the first instance, confined its attention to the alloys of copper, and the terms defined in the report are "brass" and "bronze." When the word "brass" alone is used, it denotes an alloy of zinc and copper only, containing over 50 per cent of copper. When an alloy containing a third metal, such as tin, is to be denoted, the name of the additional element should be used as a prefix; thus, an alloy containing 1 per cent of tin, 29 per cent zinc, and 70 per cent copper would be called "tin-brass." The word "bronze" denotes an alloy of tin and copper containing more than 50 per cent of copper, additional metals being denoted as above. These two names represent by far the most widely used alloys, and the general adoption of the terms thus defined would do much to remedy the state of confusion which exists at the present time.

* * *

A material called "elianite," which has been produced in the electric furnace by Dr. C. Rossi, manager of a nitrate acid works at Legnano, Italy, is claimed to be proof against all acids. This material has about 75 per cent of the tensile strength and from 25 to 75 per cent of the compressive strength of cast iron. Its hardness is about 60 per cent greater than that of cast iron and its melting point is 2500 degrees F. Elianite can be cast and is suitable for use in large apparatus used in the acid-producing industries.

EFFICIENCY TEST OF A STOCKBRIDGE SHAPER

In connection with the experimental engineering work of the Worcester Polytechnic Institute, Worcester, Mass., tests were recently conducted with the view of determining the mechanical efficiency of a Stockbridge shaper and also the number of cubic inches of metal which the shaper was capable of removing for each horsepower hour of power supplied to the tool. For this purpose, it was necessary to equip the shaper with a special table upon which the dynamometer was mounted. The shaper equipped in this way is shown in Figs. 1 and 2 and Fig. 3 is a chart showing the results of the test.

The work upon which the tool was engaged during the test was held in a special chuck. This chuck had to be carefully

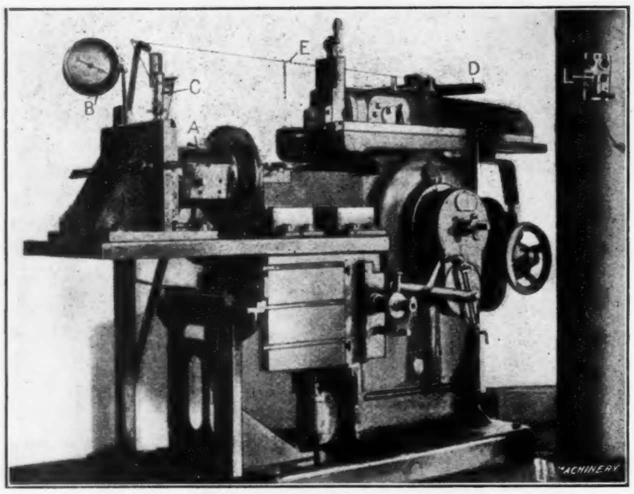


Fig. 1. Stockbridge Shaper equipped for conducting an Efficiency Test

lined up with the direction of travel of the tool in order that the full pressure might be applied to the dynamometer. The first table which was used to support the dynamometer was a little wider and considerably longer than the regular table of the shaper. This arrangement left a large part of the auxiliary table unsupported, with the result that vibration was set up which would have materially affected the accuracy of the results obtained. Several methods of overcoming this difficulty were considered, such as the use of a supporting chain secured to the ceiling. A number of people in the shop, who had not given the matter careful attention, suggested the use of jack-screws, overlooking the fact that the cross-feed of the shaper table was used during the conduct of the test. The difficulty was finally overcome by modifying the design of the table to reduce its length and the amount of overhang, with the result that vibration was eliminated.

The form of dynamometer *A* finally adopted for measuring the effective pressure of the tool consisted of a cylinder and piston, the cylinder being partially filled with oil. This simple though accurate dynamometer was used in connection with a pressure gage *B* and steam engine indicator *C*, as shown in Figs. 1 and 2. No calibration tests were necessary and it was a very simple matter to refill the cylinder with oil without admitting any air. This was done by removing the indicator, compressing the oil in the cylinder until it commenced to flow out, and then slowly drawing the piston back and pouring oil in rapidly enough to keep the cylinder filled at all times. The indicator was attached to the dynamometer cylinder in the same way as in the cylinder of a steam engine, and indicator cards were taken to determine the mean effective pressure. The results obtained were more accurate than those that could have been secured by reading the gage, as the latter fluctuated considerably, owing to variations in the hardness of the cast iron operated upon. A pantograph *D* was used as a reducing motion for the indicator and another difficulty was experienced in connection with this part of the apparatus. The indicator moved with the table when the cross-feed was in operation, and if the length of the indicator cord were adjusted when the table was in one extreme position, it would have been out of adjustment when the table was fed over two or three inches. Therefore a hook was fastened to the cord about 2 feet from the indicator, and instead of having one loop on the end of the cord attached to the pantograph, a number of small rings *E* were tied to the cord at intervals of 1 inch. It was then merely necessary to secure the hook to any one of these rings that gave the proper length of cord while a card was being taken.

One more difficulty experienced in connection with the dynamometer was that of providing means for rotating its piston to overcome the effect of static friction, the reason for taking this precaution being the same as that which leads one to spin the piston of a dead weight gage tester. The first method that was tried consisted of wrapping a wire around the piston rim, with one end terminating in a heavy weight and the other end carried over a series of pulleys and secured to the cross-feed reciprocating motion. This was a failure for three reasons: First, the sharp turns over the pulleys eventually caused the wire to break, and cord of any kind could not be used because it stretched; second, the reversal of the direction of motion of the cross-feed being slow, there were periods when the turning motion imparted to the piston was not active; third, the power required to rotate the piston could not be measured and so could not be considered in the results of the test. The next method that was considered consisted of placing a small pulley on a shaft directly above the dynamometer and carrying a belt from this shaft to the countershaft. A second belt from this intermediate shaft was connected to the rim of the piston *K*, in this way causing the piston to be rotated at a suitable speed. This rig would have required a considerable amount of time to set up and was replaced by a method which proved entirely satisfactory. This consisted of taking power from the platen of a planer *F* which moved at right angles to the shaper ram, to rotate the dynamometer piston. The mechanism employed for this purpose consisted of a piece of flat steel *G* bent to the shape shown in Fig. 2. One end of this link was bolted across the planer table and a straight flat link *H* was secured to the other end by means of a pin joint. The opposite end of this link was connected to a flat link *J* secured to the rim of the piston *K* by means of another pin joint. By running the planer on short stroke, the desired rolling of the piston was accomplished in a very satisfactory manner.

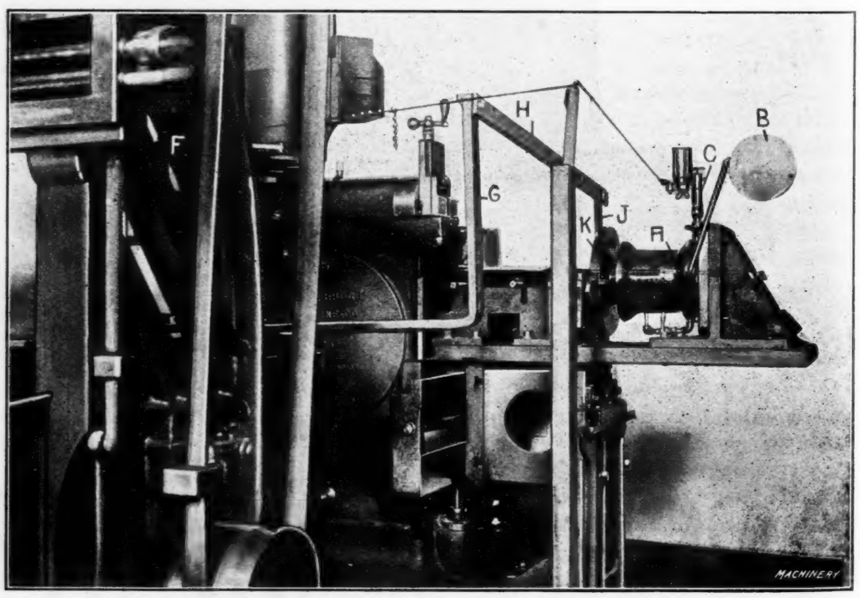


Fig. 2. Apparatus used for rotating the Dynamometer Piston

The shaper was driven by a 7½-horsepower direct-current Westinghouse motor, which was run at 975 revolutions per minute and belted to the shaper by a 3-inch double belt. The motor operated on 31 amperes at 220 volts. The center dis-

tance between the motor and shaper pulleys was 11 feet and the shaper pulley was of a size to run at 300 revolutions per minute. A brake test of the motor was made to determine its efficiency.

The integrating watt meter used to determine the power supplied to the motor was intended for a 110-volt circuit and the motor for 220 volts. Therefore, the necessary resistance was connected in series with the resistance already in the meter, so that the power in a 220-volt circuit could be measured after the meter had been calibrated to determine a new constant. The constant determined in this way was checked while the brake test of the motor was being made. The meter was so connected that it could be switched in or out without requiring the motor to be stopped, the switch L being provided for this purpose.

After preliminary tests had been made, it became evident that a more solid foundation than is ordinarily required for

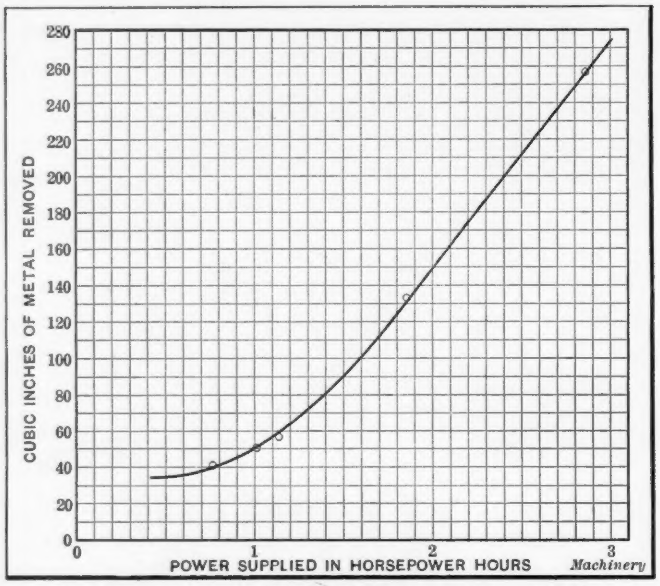


Fig. 3. Chart showing Relation of Horsepower Hours to Cubic Inches of Cast Iron Removed

a shaper was absolutely necessary if accurate results were to be obtained. The first foundation employed was not satisfactory, so a planer was moved in order to obtain the support of the brick piers under it, and the shaper set up in its place. Wedges were driven between the top of the piers and the beams to which the flooring was nailed and the shaper fastened in place by four ⅝-inch lag screws. The foundation provided in this way was perfectly rigid and enabled very satisfactory results to be secured.

The power supplied to the shaper was determined in the following manner. The total electrical power supplied to the motor during the test was recorded by means of the integrating watt meter and a brake test was made to obtain a curve of the watts-input to the motor as compared with brake horsepower. There was evidently a power loss in the belt drive but owing to the impossibility of reproducing the conditions of loading, a belt test was out of the question. Therefore this loss was assumed to be 4 per cent of the power at the motor pulley and a new curve was plotted, taking this belt loss into consideration. This gave the watts-input against horsepower delivered to the shaper pulley.

The power expended at the tool point was measured as follows: The pressure of the tool point against the work was obtained from indicator cards which, theoretically, should be rectangles. Owing to variations in the hardness of the cast iron, however, the upper part of the cards varied in height. The mean effective pressure in pounds per square inch was obtained from the cards, and knowing the area of the piston to be 20 square inches, the total force was calculated. The number of strokes per minute were recorded and also the duration of the test. This gave the force, the distance and the time, from which the horsepower was figured. For a given depth of cut and cross-feed, a number of short tests were made because five minutes was sufficient to feed the tool across the work. Therefore, at the beginning of a test the time was noted and the meter switch thrown in. Just before finishing the cut, the switch was pulled and the exact time noted. After completing such a test another cut of the same depth and cross-feed would be employed for a subsequent test, the operation being repeated until enough power was registered on the meter to insure accurate reading of the dials. The mechanical efficiency of the shaper was obtained by dividing the power expended at the tool—as determined by the dynamometer—by the power supplied to the machine by the motor. The number of cubic inches of metal removed was figured, and knowing the number of horsepower hours, the number of cubic inches removed per horsepower hour was figured. The results of this part of the test are shown in Fig. 3.

* * *

NATIONAL METAL TRADES ASSOCIATION CONVENTION

The sixteenth annual convention of the National Metal Trades Association, held at the Hotel Bancroft in Worcester, Mass., April 20-22, was one of the most successful in point of attendance ever held. The registration of members and others attending was 294, a number considerably larger than that registered at the last New York meeting. President W. A. Layman of the Wagner Electric Mfg. Co., St. Louis, Mo., presided, assisted by John D. Hibbard, the commissioner succeeding Robert Wuest, who had so ably conducted the affairs of the association for years. The report on industrial education by F. A. Geier was discussed by C. A. Prosser of the National Society for the Promotion of Industrial Education, Louis H. Buckley of the Worcester Independent Industrial Schools, and W. B. Hunter, who presented the Fitchburg plan of industrial education.

W. H. Van Dervoort presented a report on industrial accidents which was discussed by M. W. Alexander and W. H. Doolittle. The cause of accident prevention is growing and the movement is being greatly accelerated by educating the workmen to use their intelligence in avoiding dangerous acts. Justus H. Schwack of William Sellers & Co., Inc., Philadelphia, Pa., discussed the general subject of publicity.

The program for Wednesday forenoon and afternoon comprised "Results of Applied Scientific Management," by George D. Babcock of the H. H. Franklin Mfg. Co., Syracuse, N. Y.; "Basic Principles of Industrial Organization," by Prof. Dexter S. Kimball, Sibley College, Cornell University; "Work of the Bureau of Foreign and Domestic Commerce and the Plans of the Department for Its Development," by Albertus H. Baldwin, chief of the Bureau of Foreign and Domestic Commerce, Washington, D. C.; "Labor Legislation," by Walter G. Merritt, American Anti-Boycott Association, New York City.

The following officers were elected: President, Herbert H. Rice, Waverly Co., Indianapolis, Ind.; first vice-president, L. H. Kittredge, Peerless Motor Car Co., Cleveland, Ohio; second vice-president, George Mesta, Mesta Machine Co., Pittsburg, Pa.; treasurer, F. C. Caldwell, H. W. Caldwell & Son Co., Chicago, Ill.

The convention was closed with a banquet in the evening at the Hotel Bancroft, attended by over 250, at which W. A. Layman was toastmaster. Dr. J. Lawrence Laughlin of the University of Chicago and Dr. W. H. P. Faunce, president of Brown University, made the addresses of the evening.

* * *

Filing machines, while designed primarily for filing the clearance in dies, are used advantageously for lapping and filing parts to size. One well-known maker of drafting instruments employs filing machines for reducing German silver parts to size and shape. The parts are held in simple jigs and a boy runs the machine, moving the jig up to a stop and sliding it along until the work is finished. The filing machine is required to remove but little material and is especially advantageous on such work. The parts could not be held firmly enough to be milled without marring and distorting them, and the amount to be removed would make a milling operation almost absurd even if it were practicable. The same type of filing machine is used in armories for filing gun sights and similar parts.

PERSONALS

W. H. Sherman has been made superintendent of the W. P. Davis Machine Co., Rochester, N. Y.

Ralph E. Flanders has been made manager of the Jones & Lamson Machine Co., Springfield, Vt.

N. K. B. Patch has been appointed superintendent of the Lumen Bearing Co.'s plant at Buffalo, N. Y.

H. P. Parrock, manager of the Lumen Bearing Co., Buffalo, N. Y., has completely recovered from his recent illness.

J. B. Slagle, who worked in Harrisburg, Pa., and Muskegon, Mich., is requested to communicate with the Lyons Machine Works, Lyons, Iowa.

F. H. Brown, formerly sales manager of the W. P. Davis Machine Co., Rochester, N. Y., has been made secretary and treasurer of the company in place of C. F. Davis, who has resigned.

A. S. Baldwin, formerly general manager of the Alberger Pump & Condenser Co., Newburg, N. Y., has resigned his position, and will become manager of works of the Best Mfg. Co. of Pittsburg, Pa.

Leroy M. Curry, who was with the Aurora Automatic Machinery Co., Chicago, Ill., as tool designer, has resigned and taken a similar position with the Wood Turret Machine Co., Brazil, Ind.

Robert Wilde has resigned as superintendent of the gear department of the Warner Gear Co., Muncie, Ind., to become a consulting gear engineer. Mr. Wilde will give his attention to all classes of gear work.

Ludwig Swenson, for several years in the special machinery department of the Barber-Colman Co., Rockford, Ill., has been made secretary and general manager of the Rockford Lathe & Drill Co., Rockford. C. W. Holmquist, who formerly held this position, has resigned to take charge of his coal and lumber business.

Walter C. Allen has been elected vice-president of the Yale & Towne Mfg. Co. Mr. Allen has been general manager of the company for the past five years, and as such, has had charge of the sales policy and management in all departments of the business at home and abroad excepting the bank lock department. As vice-president and general manager, he will continue to perform the same duties as heretofore.

Frederick L. Hickok, formerly sales manager of the Ingersoll Milling Machine Co. of Rockford, Ill., has joined the staff of MACHINERY, and will devote his time to field service work for advertisers, cooperating particularly with them for the development of business. Mr. Hickok was born in Ashtabula, Ohio. He is a graduate of the Case School of Applied Science, Cleveland, and has an all-around mechanical experience that especially qualifies him for the line of work he has taken up.

* * *

OBITUARIES

John S. McLean died of pneumonia at his home in Readville, Mass., March 26, aged fifty-four years. Mr. McLean had been in the employ of the Prentiss Tool & Supply Co. at its Boston branch as selling representative for twelve years. He was a man of estimable character, well and favorably known in the machine tool trade.

COMING EVENTS

May 1-October 31.—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

May 19-20.—Annual convention of the International Association of Manufacturers, at the Waldorf-Astoria Hotel, New York City. George S. Boudinot, 30 Church St., New York City, secretary.

June 10-12.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

June 16-19.—Spring meeting of the American Society of Mechanical Engineers, Minneapolis and St. Paul, Minn. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

June 30-July 4.—Annual meeting of the American Society for Testing Materials, Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Warburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 15-22.—Second International Congress of Consulting Engineers, to be held in Berne, Switzerland.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. 1914 catalogue. 56 pages, 6 by 9 inches.

Northwestern University, Chicago, Ill. Annual catalogue 1913-1914. 485 pages, 6 by 9 inches.

Syracuse University, Syracuse, N. Y. Bulletin of the university for March, 1914. 503 pages, 5½ by 8½ inches.

Beloit College, Beloit, Wis. Beloit College bulletin for March, 1914, being the sixty-seventh annual catalogue issued by this institution. 168 pages, 5½ by 8 inches.

University of Vermont and State Agricultural College, Burlington, Vt. Catalogue for 1913-1914 and announcements for 1914-1915. 260 pages, 5¼ by 7¾ inches.

Columbia University, New York City. Bulletin containing announcements of the summer session which extends from June 3 to September 23. 175 pages, 6 by 9 inches.

Armour Institute of Technology, Chicago, Ill. Bulletin for May, 1913, containing general information on the calendar, curriculum, etc., of the institute. 192 pages, 5¾ by 8½ inches.

Massachusetts Institute of Technology, Boston, Mass. Bulletin containing 1914 reports of the president, treasurer and other administrative officers. 142 pages, 5¾ by 8¾ inches.

Rensselaer Polytechnic Institute, Troy, N. Y. Rensselaer Polytechnic Bulletin for December, 1913, giving general information on the undergraduate and graduate courses and student organizations.

University of Wisconsin, Madison, Wis. An engineering experiment station has been created by the board of regents. The organization will be established in the College of Engineering and will have general charge of the testing and research work of the college. The staff of the station will consist of the dean as director, and the members of the instructional staff in the various departments of the College of Engineering. In addition to these will be fellows, scholars and assistants who may be engaged in experimental and research work.

Department of Education, City of Waterbury, Waterbury, Conn. Form 51-B, giving information concerning the continuation school for machine shop apprentices. Apprentices from the various shops are eligible to membership provided their employers insist that they comply with all rules and agree to pay them while in attendance at the school. The subjects covered during the four years course are: shop mathematics, reports and discussions of special topics, articles from trade journals, etc., shop talks, history and civics, hygiene, drawing, mechanics and strength of materials.

Tri-state College, Angola, Ind. Annual catalogue 1913-1914. 125 pages, 5¼ by 7¾ inches. The Tri-State College comprises three branches, viz., the Tri-State Normal College, the Tri-State College of Pharmacy and the Tri-State College of Engineering. The college of engineering offers courses in civil, electrical and mechanical engineering, each of which requires but two years for graduation. A student may enter with an ordinary common school education. In addition to the regular courses, special courses are given in shop practice, wood, bench and lathe work, patternmaking, foundry work, forging, and tool-making.

Pratt Institute, Brooklyn, N. Y., holds its annual exhibition Thursday, April 30, from 2 P. M. to 10 P. M.; Friday, May 1, from 10 A. M. to 10 P. M., and Saturday, May 2, from 10 A. M. to 5 P. M. The exhibition is open to the public and a cordial invitation is extended to all interested in industrial and technical education. The students will be engaged at their regular work and an opportunity will thus be afforded to visitors to inspect the methods, equipment and general facilities of the school as well as the work of the students in the various courses. The School of Science and Technology should prove of special interest to men engaged in technical and trade pursuits. This school provides instruction in applied mechanics and machine design, applied electricity, applied chemistry and tanning, machine work and tool-making, carpentry and building, patternmaking, plumbing, foundry and forge work and sheet metal work.

University of Wisconsin, Madison, Wis. The demand for professionally-trained mechanics to teach in industrial schools has led the regents to create fifteen industrial scholarships. Each scholarship carries with it a special honorarium of $40 and the holders are to be organized into a mechanics' institute. The purpose of the institute, which will be held on the campus of the university from March 9 to April 9, will be to give intensive practice in special lines of shop work and drawing, and to give a detailed consideration of organization and teaching problems that confront industrial schools. The need for such an institute is manifested by the fact that men enrolled in the special industrial and trade teachers' courses given in Milwaukee and in Madison by the university for mechanics interested in teaching, have in many instances been urged to accept appointments to teaching positions before completing their preparatory work.

NEW BOOKS AND PAMPHLETS

Mechanical Drawing, Part I. Third revised edition. By Oscar E. Perrigo. 44 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

Mechanical Drawing, Part II. Third edition. By Oscar E. Perrigo. 44 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

Report of the Director of the Bureau of Mines for the Fiscal Year ended June 30, 1913. 118 pages, 5¾ by 9 inches. Published by the Bureau of Mines, Washington, D. C.

Gage Making and Lapping. MACHINERY'S Reference Book No. 64. Second Revised Edition. 40 pages, 6 by 9 inches. 39 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Tariffs on Machinery, Machine Tools and Vehicles. Published by the Bureau of Manufactures of the Department of Commerce and Labor, Washington, D. C., as No. 3 A of the Tariff Series. 34 pages, 6 by 9 inches.

Industrial Research in America. By Arthur D. Little. 23 pages, 6 by 9 inches. Reprinted by Arthur D. Little, Inc., chemists and engineers, Boston, Mass., from the "Journal of Industrial and Engineering Chemistry," October, 1913.

The Law of Patents for Designs. By William L. Symons. 300 pages, 6 by 9 inches. Published by John Byrne & Co., Washington, D. C. Price $3.

This work was prepared with particular reference to the practice obtaining in the prosecution of applications for design patents in the United States Patent Office as shown by the rules and decisions. It treats of the Design Patent Statutes; Subject Matter for Design Patent; Inventions; Novelty and Infringement; Applications and Letters Patent; and Procedure in the Patent Office.

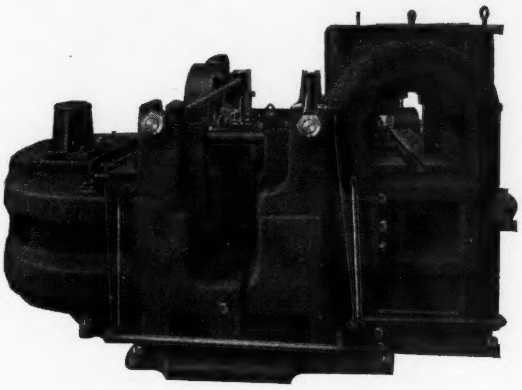
Hydraulics. By Ernest H. Sprague. 184 pages, 4½ by 7¼ inches. 89 illustrations. Published by Scott, Greenwood & Son, London, England, and sold in the United States by D. Van Nostrand Co. New York City. Price $1.

This work was compiled chiefly from the author's lecture notes at the University Club, London. The aim has been to present the subject in a concise and useful form. Many examples illustrating the principles are given and the answers have been carefully checked. The work would appeal particularly to those studying at home were it not for the fact that the author has used the calculas quite freely. The contents by chapter heads are: Introduction and the Principles of Fluid Pressure; Liquids in Motion; Discharge through Orifices, Weirs, etc.; Flow in Pipes and Channels; Pressure of Water and Application to Motors; Pumps, Miscellaneous Examples; Useful Data; Mathematical Tables.

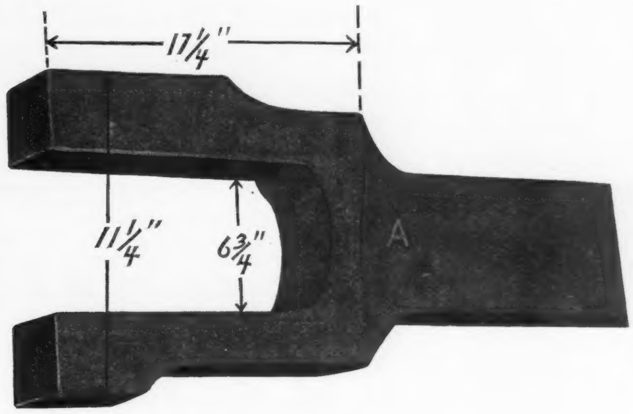
The Steel Foundry. By John Howe Hall. 271 pages, 6 by 9 inches. 37 illustrations. Published by the McGraw-Hill Book Co., New York City. Price, $3.

This book deals with the metallurgy of the steel foundry from the point of view of the engineer. It considers the classes of steel castings in general commercial demand and their characteristics from a manufacturing point of view. It deals with the common steel-making processes and their characteristic features, and explains the procedure in the shop, such as molding, coring, annealing, etc., in the light of its influence on quality and cost. The chapters of the book are headed as follows: General Considerations Governing the Choice of a Method of Steel Making; The Crucible Process; The

From A Locomotive Rod



Ajax Universal Forging Machine.



PROBABLY you do not make either of these pieces in your shop, but you do make duplicate parts somewhere between these two sizes—parts that could be forged to advantage on

Ajax Forging Machines

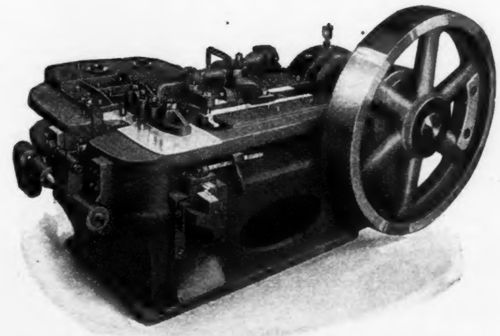
They are used in nearly every line of iron and steel manufacturing. Automobile builders, implement makers, bolt and nut manufacturers, carriage factories, railroad shops, ship builders, are all big users of Ajax Machines.

This locomotive side rod was produced on an Ajax Universal Machine in the Chicago shops of the C. & N. W. and it is the largest job they ever made on a forging machine.

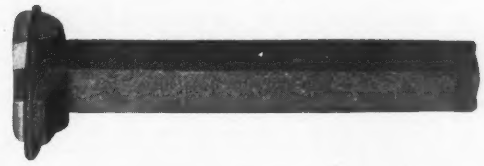
The track bolt is made by a manufacturer in Australia using an Ajax Continuous Motion Heading Machine. He is producing 30,000 per day where he used to make 5,000 by former methods.

Is there a chance like this to cut costs in your shop? You can find out by just sending a blueprint or a sample part. We tell you without cost or obligation just what the Ajax Machine will do on any forging job.

Down To A Track Bolt



Ajax Continuous Motion Heading Machine.



The Ajax Manufacturing Company

Chicago Office
621 Marquette Bldg.

Cleveland, Ohio

New York Office
1369 Hudson Terminal

Bessemer Process; The Open-hearth Process; The Electric Furnace; Summary—Special Deoxidizers—Ladles; Molding, Pouring and Digging Out; Heat-treatment and Annealing; Finishing, Straightening and Welding; Laboratories; "Building-up" Impurities in Steel.

Engineers' Costs and Economical Workshop Production. By Dempster Smith and Philip C. N. Pickworth. 248 pages, 5½ by 8½ inches. Illustrated. Published by Emmott & Co., Ltd., Manchester and London, England. Price, 4s. 6d., net.

The effort of this work is to give clearly and simply the principles of manufacturing costs with various problems and methods of solution. Particular attention has been given to methods of correct time fixing in determining the cost of machine operations. The contents by chapter heads are: Pig Irons; Wrought Irons and Steel; Copper and Copper Alloys; Specification of Materials; Wage Systems; Shop Organization and Management; Considerations Affecting Standard Times for Machine Operations; Considerations Affecting Standard Times—Machine Capabilities; Standard Times for Hand Operations; Inspection of Work and Classes of Fit; Establishment Charges; Reserve, Maintenance and Depreciation; Selling Expense; Railway Rates; Shipment of Goods; Cost Keeping; and Estimating.

Alloy Steels—Their Composition, Characteristics, Strength and Heat-treatment. By E. F. Lake. 47 pages, 6 by 9 inches. 16 illustrations. 13 tables. Published by the Industrial Press, New York City. Price, 25 cents.

This book is No. 118 of MACHINERY'S Reference Series. The important part which alloy steels play, at the present time, in the machine building and manufacturing trades will make a book descriptive of these steels especially valuable to the mechanical world. The book contains a number of comprehensive treatises on the most commonly used alloy steels, including nickel steel, nickel-chromium steel, vanadium steel, manganese steel, titanium steel, and natural alloy steel. In the case of each, their characteristics and peculiar properties are reviewed, and the uses for which they are adapted referred to. Their strength and the methods of heat-treating in order to obtain the best results from each steel are given. As there is no book on the market treating of these classes of steels in a similar manner, it will be especially welcome to all interested in this subject.

The Modern Gasoline Automobile. By Victor W. Page. 816 pages, 5¼ by 7½ inches. 575 illustrations. Published by Norman W. Henley & Son, New York City. Price, $2.50.

This is the third, or 1914, edition of this work, which treats of the design, construction and maintenance of the gasoline automobile. The major portion of the previous edition remains unchanged, but much additional matter has been included in order to keep pace with the progress of the automobile industry. Supplementary matter has been added relating to ignition and magneto-generators, as well as entirely new material on many important subjects. Mechanically interesting sections that have been augmented are those on the skew-bevel gear and two-speed, direct-drive rear axle, as well as the discussion on several new forms of worm-gear drive. It may well be said that, in general, this book presents a most comprehensive treatise on the gasoline automobile and may well be recommended both to owners and users of automobiles and to students, mechanics and repairmen. The treatment of the subject makes it also especially valuable as a reference book for draftsmen, designers and engineers.

Gear Cutting in Theory and Practice. By Joseph G. Horner. 391 pages, 5½ by 8½ inches. 367 illustrations. Published by Emmott & Co., Ltd., Manchester and London, England. Price, 7s. 6d., net.

Mr. Horner is a well-known British authority on machine shop practice and mechanical engineering work generally, of indefatigable enterprise. The number of articles and books annually produced by him is remarkable. In offering this book on gear cutting to the public, the author refers to the rapid developments of machine shop practice during the past ten years. Form planing and generating planing methods have come to be applied chiefly to bevel gears and the hobbing practice is widely used as a means of generating spur gears. The growth of automobile practice and the development of all-geared machine tools have brought the high carbon steels and the alloy steels to the front. The difficulty of cutting gears of these steels and the requirements for hardening have increased the demand for expert knowledge on the part of the modern gear maker. The work treats of: Elements of Tooth Forms; Tooth Curves; Pitches; Tooth Proportions; Gears Related to the Spurs; Bevel Gears; Method of Cutting; Form Cutters; Form Planing and Generating Methods; Machines Using Form Cutters; Form Planing; Machines that Generate by Planing Tools; Machines that Generate Bevels by Planing; Generating by Hobbing; Generating by Milling; Materials, Manufacture and Strength of Gears. The work treats modern gear making comprehensively and will be generally acceptable to the mechanical public interested in gearing.

NEW CATALOGUES AND CIRCULARS

Colburn Machine Tool Co., Franklin, Pa. Bulletin 54 on D-3 heavy-duty drill press of 24 inches swing.

E. J. Willis Co., 85 Chambers St., New York City. 1914 catalogue A, offering special cut-rate prices for automobile supplies.

Waterhouse Welding Co., Boston, Mass. Catalogue on welding and cutting plants, listing the parts that comprise the different equipments and prices of each.

Merrell Mfg. Co., Toledo, Ohio. Catalogue comprising bulletins 14 to 22 on pipe threading and cutting machinery of both hand and power types. 35 pages, 6 by 9 inches.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Leaflet giving price lists and dimensions of Hess-Bright ball-bearing ceiling hangers, floor stands, post hangers and pillow-blocks.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Pamphlet on push-button operated controllers for printers' machinery by which it is claimed a large increase of production can be obtained without increase in cost.

United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. Bulletin of electric polishing and buffing machines made in six sizes, ¼ to 5 horsepower, with alternating- or direct-current motors.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin E-31 of Duntley electric sensitive drilling stand, and Bulletin E-32, superseding E-28, on Duntley electric tools for street and interurban railways.

Julius King Optical Co., New York City. Leaflets entitled "Don't Lose Your Eyes" and "Should Workmen be Compelled to Wear Safety Goggles," advertising the "Saniglas" shop goggles for protecting the eyesight of workmen.

National Machinery Co., Tiffin, Ohio. Circular 1010-B on National semi-automatic nut tappers built in 1- 1½- and 2-inch sizes. A special feature of this machine is the automatic raising and lowering of the spindles which eliminates the item of fatigue from treadling and allows an increased production.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 41010 on direct-current motors, types C and D. Folder 853 on laboratory ozone apparatus, describing ozonators, ozone mixers, air filters, etc. Folder 330 on electric fans, direct and alternating current.

Ironton Punch & Shear Co., Ironton, Ohio. Catalogue 12, descriptive of Ironton punches and shears. 48 pages, 6¼ by 9¼ inches. The line of machines illustrated and described includes vertical punches and shears, horizontal punches, universal shears, straightening rolls, bending rolls and multiple punches.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 242 entitled "Sprague Electric Control Systems for Newspaper and Rotary Magazine Presses." 31 pages, 8 by 10½ inches. Installations of the Sprague control system in a number of printing plants are shown.

Allen-Bradley Co., 495 Clinton St., Milwaukee, Wis. Bulletin B-531, describing Allen-Bradley Type G starting switches intended for use with small alternating-current motors that can be connected directly to the line without a starting resistance to limit the current. They are of the drum type, entirely enclosed in a dustproof case.

Charles H. Besly & Co., 120 N. Clinton St., Chicago, Ill. Card on the advantages of 15-30-C Besly grinder, showing the machine in operation. It is claimed that this machine so increased production as to save one-sixth of the pay roll in a large railroad patternshop. The card has a hole punched in the top and is intended to be hung up for reference.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletins 152, 153, 154 and 172 on "Chicago gatling" drills, the "Chicago sinker," the "Chicago stoper" and the "Chicago" plug and feather drill. The bulletins show clearly the application of these various types of pneumatic drills and their several advantages, and gives dimensions and prices for each.

Watson-Stillman Co., 192 Fulton St., New York City. Catalogue 91, descriptive of the Watson-Stillman line of hydraulic jacks. 96 pages, 6 by 9 inches. This line comprises plain hydraulic jacks, horizontal and swivel claw hydraulic jacks, pulling jacks, pit jacks, motor lifts and battery lifts. A miscellaneous section is devoted to repair parts and includes tables giving dimensions, prices, etc.

American Blower Co., Detroit, Mich. Bulletin 35, Series 1, dealing with the pitot tube and fan testing. The construction, operation and application of the pitot tube are described and comparisons are drawn between "ABC" pitot tubes and other types. Tests show that very accurate results are obtained in measuring air pressures and volumes in fans by the use of "ABC" pitot tubes. The method of conducting fan tests with these tubes is also described.

Wiener Machinery Co., 50 Church St., New York City. Circular of "Hercules" bending machines for bending angles, beams, channels, rails and other shapes. The material is bent cold and perfect rings can be bent from angle iron, with legs inward or outward. These machines are especially adapted for the use of boilermakers, structural shops and manufacturers of mining equipment. Railroads and street railway companies should find the rail bending machines of interest.

Brown Instrument Co., Philadelphia, Pa. Catalogue 9 treating of the complete line of indicating and recording pyrometers made by this company. 64 pages, 8 by 10½ inches. This book is virtually a treatise on pyrometers, taking up their construction, descriptions of the various types and their installation in plants throughout the country. The catalogue is well printed and illustrated, and attractively made up. A leaflet containing 100 letters of recommendation of Brown pyrometers is also being distributed.

Russell Mfg. Co., Greenfield, Mass. Bulletin A on screw plates. 32 pages, 5 by 7½ inches. Screw plates include a set of stocks, dies and taps consisting of from one to twelve sizes or more. A new feature of the Russell plates is the double die which is made to cut from both faces. This allows the die to be reversed when worn, bringing into action a new set of cutting edges and thus materially increasing the life of the die. Attention is also called to the opening-die screw plate which greatly facilitates the work of threading bolts by hand.

Graton & Knight Mfg. Co., Norfolk & Suffolk Sts., Worcester, Mass. Catalogue No. 5 on leather belting and leather products. 114 pages, 5½ by 8½ inches. This catalogue supersedes all previous editions and contains a complete description of the various brands of leather belting manufactured by this company. There are also included many mechanical rules, tables, etc., suggestions for the proper care of belts, points on ordering belting, selecting the best belt for special conditions, and other information which should be helpful to all belting buyers or users.

Starrett Pump & Mfg. Co., Salt Lake City, Utah. Booklet entitled "A Modern Method of Pumping," describing the Starrett system of pumping by compressed air. In this pump the air is used expansively, that is, the power put into the air by compression is changed from pressure into speed by expansion in the discharge pipe. It is claimed that the Starrett pump will lift water any height with any desired pressure, which makes it particularly adapted for well pumping and mine work. Tests of these pumps conducted at the University of Utah showed a very satisfactory performance.

Wagner Electric Mfg. Co., St. Louis, Mo. Bulletin 104 entitled "A Manual of Electrical Testing." 48 pages, 8 by 10½ inches. Besides describing the line of portable instruments manufactured by this company, this publication describes various types of electrical instrument movements, the errors to which they are subject, and gives suggestions for their handling and care. The methods of making electrical tests on alternating-current and direct-current motors and generators and on transformers are described at length and illustrated by comprehensive and instructive diagrams. The publication is one that should be in the hands of everyone who has to do with electrical testing. Copies may be had upon application to the Wagner Electric Mfg. Co.

Colburn Machine Tool Co., Franklin, Pa. Catalogue on Colburn boring mills arranged in the form of a binder in which the new bulletins can be inserted as received. Bulletins thus far included are Nos. 46, 58, 60, 61, 63 and 65 which cover Colburn vertical boring and turning mills of 30 inches, 34 inches, 54 inches and 72 inches capacity. Bulletin No. 63 is devoted to special features of this line of machines, among which might be mentioned the helical gear table drive which, it is asserted, gives a smooth rolling effect that entirely eliminates vibration and chatter. The Colburn Machine Tool Co. is the first to use this type of table drive for boring mills, and considers it superior to the ordinary spur gear drive. These bulletins have the usual typographical excellence of this company's publications.

Max Ams Machine Co., Mount Vernon, N. Y. Year Book for 1914 entitled "The Seal of Safety." 206 pages, 6 by 9 inches. This is a book which should be of particular value to those engaged in the canning or food packing industry, but the information contained is of considerable general interest as well. A brief history of the canning industry from its inception is given, and it will probably be a surprise to many to know that the preserving of food began as long ago as 1795, and that packing in tin cans was done in 1810. It is even asserted that various kinds of preserved foods have come to light in the excavations of ancient ruins by archeologists. The Max Ams Machine Co. was started in 1868 as a canning and packing business, and this company made many improvements in the cans then being used. From this beginning was developed the present business of building can-making machinery, and the last section of the book shows the improved types of machines made by this company for producing the modern sanitary solderless sealed can. Articles are also included on "The Canning of Vegetables and Fruits," by Dr. A. W. Bitting, "New Method of Canning," by Dr. Koch, "Process of Salmon Canning," by the secretary of the Salmon Packers' Association, etc. Other sections of the book deal with the associations in the canning and packing industries, and legal matters of interest to canners. In the latter division is the Sherman anti-trust law, an article on U. S. patent law, by Oscar E. Perrigo and other matters of much interest. This book shows considerable care in its compilation and the result is a valuable and attractive publication.

TRADE NOTES

Detroit Steel Cooperage Co., Detroit, Mich., has been succeeded by the Detroit Steel Cooperage Works of the Pfaudler Co., Detroit, Mich.

Western Tool & Mfg. Co., Springfield, Ohio, has just completed a drop-forge plant and is now in a position to take on business in this line.

C. & C. Electric & Mfg. Co., Garwood, N. J., announces the removal of its Cleveland agent, Charles S. Powell, to new headquarters at 711 Illuminating Bldg., Cleveland, Ohio.

Norma Company of America, New York City, maker of "Norma" ball, roller, thrust and com-

Left-Hand Offset Tool Holder

Straight Shank Tool Holder

Right-Hand Offset Tool Holder

ARMSTRONG TOOL HOLDERS

ARE SOLID STEEL FORGINGS

THEY HAVE NO SHIMS, LINERS OR BRAZED JOINTS TO LET GO OR WORK LOOSE

JUST SOLID STEEL FORGINGS

WITH A TOOL STEEL SET SCREW

Their simplicity, excellence of design, material and workmanship are why they stay on the job years after other tool holders are on the scrap pile.

THEY SAVE YOU
- **90% of your tool steel investment**
- **All forging**
- **Nearly all grinding**

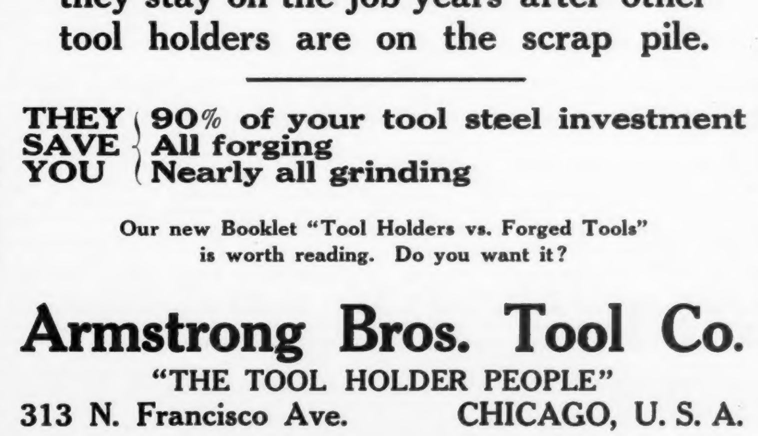
Our new Booklet "Tool Holders vs. Forged Tools" is worth reading. Do you want it?

Armstrong Bros. Tool Co.

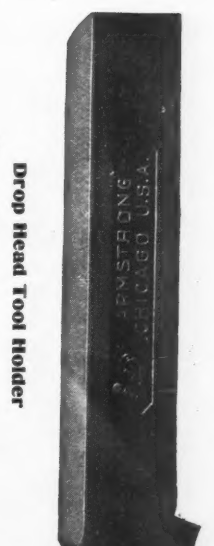
"THE TOOL HOLDER PEOPLE"

313 N. Francisco Ave. CHICAGO, U. S. A.

Planer Tool



Boring Tool



Drop Head Tool Holder

OTHER TOOLS WE MAKE—Ratchet Drills, C Clamps, Drilling Vises, Lathe Dogs, Automatic Drill Drifts, Lathe Tool Posts, Planer Jacks, Drilling Posts, etc.

bination bearings, has removed its offices from 20-24 Vesey St. to 1790 Broadway, New York City.

Foote-Burt Co., manufacturer of single and multiple spindle drilling machines and Reliance bolt cutters, Cleveland, Ohio, opened an office on April 1 at 436 Wells Bldg., Milwaukee, which will be in charge of Charles Gordon.

Ingersoll-Rand Co., 11 Broadway, New York City, announces that Walter A. Johnson, formerly at Atlanta, Ga., has been appointed pneumatic tool manager of its Pittsburg branch and C. F. Overly of Pittsburg, pneumatic tool manager of the company's Cleveland branch.

Technical League of Engineers and American Society of Engineer Draftsmen, both incorporated, have been merged into a new organization to be known as the Technical League of America with headquarters at 74 Cortlandt St., New York City, Walter M. Smyth, general secretary.

Lumen Bearing Co., Buffalo, N. Y., has commenced to manufacture and market a new graphite compound called "Lesoyl." This is put up in a standard can, to be mixed with five gallons of oil or ten gallons of grease. It is claimed that the lubricating of bearings may be more efficiently and economically done by the use of this compound.

Mumford Molding Machine Co., Chicago, Ill., has closed its New York office and E. H. Mumford, vice-president and general manager, has moved his office to the factory, 2059 Elston Ave., Chicago, Ill., in order that he may be in close touch with the business. Mr. Mumford may be reached personally while in New York by addressing him care of Machinery Club, 50 Church St.

Ingersoll-Rand Co., 11 Broadway, New York City, has opened a new branch office and warehouse in Los Angeles, Cal., at 1036 Union Oil Bldg. This branch will be in charge of W. A. Townsend, formerly manager of the company's El Paso office. Mr. J. D. Foster succeeds Mr. Townsend as manager of the El Paso office. The company has also opened a branch in Juneau, Alaska, in charge of Frank Carroll.

J. L. Osgood, Buffalo, N. Y., has moved his offices in the Erie Co. Bank Bldg. to a ground floor location at 43 Pearl St. The shops will be located on the four floors above, where the manufacture of file handles will be continued and the production of a line of patent oil-hole covers will be taken up. In addition, the manufacture of a cross milling attachment for use on turret lathes will be carried on.

Lumen Bearing Co., Buffalo, N. Y., announces affiliation with the American Die Casting Co., 375-383 Kent Ave., Brooklyn, N. Y. At a recent meeting of the stock-holders, William Barr, president of the Lumen Bearing Co., was elected vice-president of the American Die Casting Co. The purpose of the affiliation is to combine the modern facilities of both organizations for the purpose of supplying high-class white metal die-castings.

Link-Belt Co., Inc., Chicago, Ill., manufacturer of the Link-Belt silent chain drive for the transmission of power, elevating and conveying machinery, locomotive cranes, power house conveyors for coal and ashes, etc., announces the opening of an office at Room 911, Dime Bank Bldg., Detroit, Mich. Mr. L. W. Longan, formerly connected with the Chicago and Indianapolis Works of the Link-Belt Co., will be in charge of the Detroit office.

Moltrup Steel Products Co., Beaver Falls, Pa., has been organized and incorporated with a capital of $50,000 to manufacture cold-drawn steel bars in flat, square and special shapes, finished machine keys and other ground and milled specialties. The company has purchased the plant of Emerson Smith & Co., Beaver Falls, and will continue the manufacture of Emerson circular and band saws, hammered, ground and polished plates and disks. The officers are J. T. Moltrup, president; M. P. Simpson, vice-president; Stephen Moltrup, treasurer; F. H. Guppy, secretary. All the incorporators of the company were formerly connected with the Standard Gage Steel Co. of Beaver Falls.

Julius King Optical Co., 10-12 Maiden Lane, New York City, is distributing a safety bulletin issued by the Safety Department of the American Car & Foundry Co. The object of this bulletin is to help in the work of accident prevention, with special reference to the protection of the eyes. The King safety goggles here shown are made of glass which is practically unbreakable and are so constructed that even if the glass is cracked it will be securely held and prevented from entering the workman's eyes. Photographs showing accidents which have occurred through workmen neglecting to wear goggles emphasize the need for every shop to enforce this kind of protection.

Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass., have just received the English patents for a power feed mechanism for drilling machines, invented by Prof. William W. Bird, director, and Louis W. Rawson, superintendent of the Washburn Shops. The Washburn Shops have issued a license to Alfred Herbert, Ltd., of Coventry, England, the largest drill manufacturers in the United Kingdom, for the exclusive right to equip its machines with the device in the British Isles. The particular feature of this device lies in the fact that the drill is brought forward to the work in the same manner as in any ordinary hand feed sensitive drilling machine, but the instant the drill meets the resistance of the work the power feed is automatically engaged. A stop motion is provided which disengages the feed when the required depth is reached and the spindle is returned automatically to its original position.

Foote Bros. Gear & Machine Co., 210 N. Carpenter St., Chicago, Ill., owing to the unusual demand for large heavy cut gears where cast tooth gears have been used heretofore, has placed in its plant a large automatic gear-cutter built especially by Gould & Eberhardt. This machine is arranged to cut special gears and hob worm-gears up to 150 inches diameter, 20 inches face and 6 inches circular pitch. The hobbing department has also been increased to take care of helical and spiral cut gears up to 40 inches diameter, and the automatic screw machine department has had the addition of several large machines, which handle bar work up to 4½ inches diameter. A generator for cutting spiral tooth bevel gears up to 18 inches diameter will be installed shortly. Owing to the large amount of modern tools recently installed, it has been found necessary to lay out 10,000 square feet more of floor space for the machine shop. With these changes and additions the firm will be better equipped than ever to take care of its ever increasing gear business.

Miscellaneous Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents

HARDENING, Carbonizing, Galvanizing. C. U. SCOTT, Head of Wall St., Davenport, Iowa.

BOOKS ABOUT ELEVATORS.—Best published. W. A. MORSE, 19-21 Union Place, Yonkers, N. Y.

LIVE SHOP AGENTS WANTED to distribute our tools. WELLES CALIPER CO., Milwaukee, Wis.

GET A "LAST WORD."—The Test Indicator Par Excellence. H. A. LOWE, 1374 E. 88th St., Cleveland, O.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

DISC CALCULATING CHARTS for draftsmen and designers. CARPENTER DRAFTING CO., 49 Oakland Terrace, Hartford, Conn.

WANTED.—Copy of April, 1910, MACHINERY. Address BENJAMIN ELECTRIC MFG. CO., 120 So. Sangamon St., Chicago, Ill.

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

WANTED.—MODERN PLAIN RADIAL DRILL with three or four foot arm. Must be in first-class condition. State price. SARANAC MACHINE CO., Benton Harbor, Mich.

AUTOMATIC AND SPECIAL MACHINES designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

GENERAL MACHINERY DESIGNED.—Working drawings; tracings; patent office drawings; general drafting. Accuracy, prompt attention. SAMUEL GOODMAN, 21 Park Row, New York.

FOUNDRY FOR SALE.—Five-ton capacity, in best railroad town in northwestern Ohio. Good location for practical foundry man. Address Box 641, care MACHINERY, 140 Lafayette St., New York.

WANTED.—DRAFTSMAN who is accurate and rapid on lettering and printing. Send sample of work. State name, age and wages wanted. Address X. Y. Z., Box 638, care MACHINERY, 140 Lafayette St., New York.

HANDBOOK for Machinists and Toolmakers (vest pocket size), condensed information most needed in the shop; also general information for shop men. 120 pages; 25 cents. WM. CUTHBERTSON, 39 Springside Ave., Pittsfield, Mass.

POSITION WANTED.—TOOL-ROOM FOREMAN desirous of making change if better than present position. Can design tools and get the highest efficiency out of tool-room. Address Box 637, care MACHINERY, 140 Lafayette St., New York.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. Trademarks registered.

FOR SALE.—One used 11 x 24 "Murray" Corliss Engine, right hand. Band Fly Wheel 8' x 14"; 4800 lbs. Shaft 5½" x 7' 1½" long. All in first-class order. Here is a fine machine for some one. MATHIAS KLEIN & SONS, 562 W. Van Buren Street, Chicago, Ill.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

SEVERAL DRAFTSMEN WANTED.—Applications solicited from men with either Ordnance, Mechanical or Mechanical-Electrical experience. State fully age, experience, education and wages expected. Address Box 640, care MACHINERY, 140 Lafayette St., New York.

FOR SALE.—One No. ½ Schuchardt & Schutte Gear Hobber for cutting spiral or spur gears. Will cut gears up to 16" diameter in first-class shape; complete with all gears. Make us an offer. STEWART-WARNER SPEEDOMETER CORPORATION, 1826-52 Diversey Blvd., Chicago, Ill.

TOOLMAKER WANTED.—Experienced on jig and fixture work; die experience not necessary. Steady position for capable man. Write stating age, experience, pay required and references with time of employment with each one. Address Box 639, care MACHINERY, 140 Lafayette St., New York.

ENGINEERS, SUPERINTENDENTS, designers, draftsmen, production engineers, master mechanics, auditors and other high-grade men are invited to file their professional records with us for vacancies now open and in prospect. Only high-grade men whose records can stand investigation need apply. THE ENGINEERING AGENCY, Inc.—20th Year—Chicago.

WE ARE EXCEPTIONALLY WELL FITTED to build your light and medium weight machines on contract in reasonable lots. Can store finished material, shipping direct to consumer your single orders or in lots and take the factory end entirely off your hands. Best of shipping facilities. Prompt and efficient service. High-class workmanship. Prices right. HOYSRADT & CASE, Kingston, N. Y.

WANTED.—FACTORY MANAGER AND SUPERINTENDENT possessing executive ability and knowledge of modern shop practice; capable of taking charge of factory in Greater New York producing small tools and instruments of accuracy and fine finish. Must be thorough machinist. State technical knowledge, if any, age, references and experience. Address Box 642, care MACHINERY, 140 Lafayette St., New York.

MANUFACTURING AMERICAN SPECIALTIES IN ENGLAND.—Consulting Engineer with intimate knowledge of the class of labor and working conditions in the various districts in Great Britain, visiting United States, is open to consider proposals for manufacturing American engineering productions in England. Address full particulars to "Engineer," care of Wickes & Knight, Solicitors, Finsbury House, Blomfield Street, London, E. C.

WANTED FOR THE RESALE OF A NEW PATENTED ELECTRIC RIVETING MACHINE good firm disposing of excellent connections to the iron industries. The respective firm would receive the sole agency for the United States. The above machine is constructed after new principles and offers great advantages in comparison with all other makes. Big profits can be obtained. Offers stating references and all conditions. Address Box 643, care MACHINERY, 140 Lafayette St., New York.

AUTOMATIC CASTING AND BAR WORK WANTED by a firm manufacturing a line of accurate apparatus. Capacity of casting up to 14 inches diameter; bar work, from ¼ inch to 2⅝ inches diameter, both single and multiple spindle machines. Accuracy and prompt deliveries guaranteed. An especially attractive price for large quantities. Work done in separate department, and not interfered with by standard product. Address Box 616, care MACHINERY, 140 Lafayette St., New York.

WANTED. — Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say, "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic, valuable information, condensed in pocket size. Price postpaid, $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

I WISH TO GET IN TOUCH with executives now earning from $10,000 down to $3,000 yearly, who would consider offers of new connections if they came from the right concerns—executive, technical, mechanical or professional positions. I act as personal counsel (for big men only); can serve but a few at a time; I personally promulgate difficult negotiations and systematic searches for big openings; confidentially, diplomatically; acting up to the point of interview only and not binding you. The difficult, unusual case is particularly invited. On receipt of your name and address only, will make detailed explanation of my methods without obligating you. R. W. BIXBY, Lock Box 134-B7, Buffalo.